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The MINERAL RESOURCES of MANITOBA

The Honourable John Bracken,

Premier of Manitoba.

Sir,

I have the honour to submit herewith a report on the Mineral Resources of Manitoba, being Project No.12 under the Economic Survey, and thirteenth in a series of reports covering many phases of the economic and social life of the province. This report is the work of George E. Cole, Director of Mines, Department of Mines and Natural Resources.

I have the honour to be,

Sir,

Your obedient servant,

C.B.Davidson,
Director.

Winnipeg, Manitoba.
June 11, 1938.

THE MINERAL RESOURCES OF MANITOBA

- by -

George E. Cole

ACKNOWLEDGMENTS

The author wishes to acknowledge the assistance of J.S. DeLury, Ph.D., Provincial Geologist, for a description of the geology of Manitoba as contained in Chapter V of this report. The author also wishes to acknowledge the assistance of F.D.Shepherd and W.B.Paton of the staff of the Mines Branch.

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CHRONOLOGICAL TABLE

1612- Sir Thomas Button entered Nelson River.
1619- Jans Munck discovered Churchill River.
1670- Ceding of country to Hudson's Bay company.
1732- La Verendrye reached Lake Winnipeg.
1754- Hendry reached Saskatchewan river from Hudson Bay.
1800-1876- Salt extracted from brine springs.
1812- Edwards refers to magnetite at Narrows of Knee Lake.
1821- Amalgamation of Hudson's Bay company with its rival, the North West company.
1869- Transfer of Hudson's Bay company lands (Rupert's Land), to Dominion of Canada.
1870- Northwest Rebellion.
1870- Province of Manitoba created.
1871- Stage line from railway at St.Paul, Minnesota, to Fort Garry, and first telegraph line to the same place (now Winnipeg).
1872- Steamboats on Red River.
1878- Railway from Emerson to St.Boniface, connecting with St.Paul and Pacific railroad.
1881-1889- Boundaries of Manitoba extended.
1886- First Canadian Pacific railway transcontinental train went through Winnipeg.
1889- Gypsum first reported as occurring in Manitoba by J. B. Tyrrell.
1900- Gypsum beds opened up at Gypsumville.
1910- Railway reached Gypsumville.
1911- Discovery of gold made at Rice Lake (Gabrielle property).
1912- Northern Manitoba added to the Province.
1912- The Pas incorporated as a town.
1913- The Mines Act--R.S.M.C. 113, 5-1; and the Mining Companies' Act--R.S.M.C 114,5-1, passed the Legislature.
1914- Discovery of gold made at Herb (Wekusko) Lake.
1915- Flin Flon ore body discovered.
1915- Mandy ore body discovered.
1916- Mandy property optioned to Tonopah Canadian Mines, Ltd.
Freighting to Mandy started - January.
First diamond drill to be used in Northern Manitoba at work at the Mandy property.
Two diamond drills commence work at Flin Flon- March.
1917- Mining plant at Mandy, and shaft sunk 100 feet by August.
Shipment of 2½ tons of gold-quartz ore from Moosehorn claim, Herb Lake, to Trail, B.C.
1917-1919- Mandy Mine ships copper ore to Trail, B.C.
1917-1918- Copper-nickel claims staked at Maskwa River.
1918- Scheelite mined at Falcon Lake.

1920- Discovery of copper-nickel deposits at Oiseau (Bird) River.
1920- Flin Flon property optioned to Mining Corporation of Canada and W. B. Thompson of New York.
R. E. Phelan to Flin Flon to investigate direct smelting of the ore.
Nos. 1 and 2 shafts sunk at Flin Flon.
Last shipment of copper ore from Mandy mine to Trail, B. C.
1922- Two-stamp mill installed at Elora Fractional claim, Long Lake.
1923- Mining at Onondaga claim begun, shaft sunk and five-stamp mill installed.
1924- Sherritt-Madole property staked.
1924- Lithium-bearing pegmatites near Pointe du Bois discovered.
1925- Cassiterite, oxide of tin, discovered on Shatford Lake.
1925- Minerals Separation Co. & Whitney interests negotiating with Mining Corporation of Canada for Flin Flon property.
Development work at Oro Grande--Solo claims, Central Manitoba area.
Cryderman property located for Mining Corporation of Canada.
1925-26- Gold discoveries near Gem Lake and Slate Lake.
1925-26- Extensive surface and underground developments on the Kitchener group (now Central Manitoba Mines).
1926- The Security Frauds Prevention Act, Cap. 46, passed by Legislature.
1926- First drilling on Sherritt-Madole (now Sherritt-Gordon) property in winter of 1926-27.
1926- Victoria Syndicate option and work on Cryderman property.
1927- Pilot mill in operation at Flin Flon- March.
1927- Hydro-electric power line connects Central Manitoba area with Winnipeg River.
1927- The Mines Act amended.
1927- Second Triennial Mining Congress of British Empire visits Manitoba in September.
1927- R. J. Jowsey optioned Sherritt-Gordon property. Diamond drill to Sherritt Gordon by aeroplane.
1927- Mill of 150-ton daily capacity was erected and commenced operations at Central Manitoba Mines- October.
1927- Development work at the Eldorado property, Central Manitoba area- November. San Antonio sank Nos. 1 and 2 shafts.
1927- On December 1st, Hudson Bay Mining and Smelting Company exercised its option on the Flin Flon mine.
1928- Construction of Flin Flon railway started in January, and steel reached the mine in October.
1928- Gem lake mine began operations - February.
Island Falls power development surveyed in aeroplane flights and construction started.
Cryderman property sold to Jas. Stuart and associates.
Development work started Sherritt-Gordon mine and Nos. 1 and 2 shafts sunk.
Operations resumed at Mandy mine February 26th.
Construction of plant at Flin Flon commenced.
Development work at Oro Grande mine started.

1928- The Department of Mines and Natural Resources established by Manitoba government.
1928- The Mines Act amended. Rules under the Mines Act adopted November 1st.
1929- Freighting from Cranberry Portage to Sherritt Gordon mine started - January. Steel reached mine July 28th.
Freight Flin Flon to Island Falls, machinery and supplies completed - March.
No. 3 shaft started at Sherritt-Gordon mine- April 8th.
Marble quarried at Mile 69.5 Hudson Bay railway.
Amaranth gypsum deposits developed by J. R. Spear of Winnipeg.
Drilling for oil near Vermilion River, south of Dauphin.
1929-1930- Freightingcompleted to Island Falls.
1930- Testing of equipment at Flin Flon - June.
Crushing of ore commenced at Flin Flon - June 24th.
First unit of flotation plant started at Flin Flon - July 17th.
Zinc roasters started at Flin Flon - September.
First zinc slabs produced at Flin Flon - November.
Copper roasters and reverberatory furnaces started at Flin Flon-October.
Copper production begun at Flin Flon - December.
Drilling for oil near Manitou.
Bobjo Mines Ltd. interest in San Antonio Mines, Ltd.,
San Antonio takes over the holdings of Scarab Development Co.
Transfer of Natural Resources to Manitoba, July 15th, 1930.
"The Mines Act", chapter 27, in force July 15th, 1930.
Mandy Mines Ltd., diamond drilling at Baker-Patton property.
Construction of mining and milling plant, Main shaft, Sherritt-Gordon Mines, Ltd.,
Gypsum mine opened at Amaranth.
1931- Crushing of ore commenced at Sherritt-Gordon mine, March 10th, and plant in production April 1st, shipping copper concentrate to Flin Flon smelter.
Cryderman mine renews operations.
Coal mining revived near Deloraine.
Moosehorn claim ships 17.6 tons gold quartz ore to Trail, B. C.
Discovery of gold at Island Lake.
1932- Construction of salt plant started at Neepawa, January, and production commenced August 1st.
Gem Lake mine milling ore.
Diamond drilling at Island Lake mine.
Freighting by boats to Norway House for winter haulage to Island Lake mine.
Milling commenced at Oro Grande property, July 1st.
Dominion group at Copper Lake ships gold quartz ore to Flin Flon smelter.
Cryderman Company milling.
Discovery of gold at God's Lake.
Sherritt-Gordon mine suspends operations, June.
1933- "Mining Tax Act", chapter 27, passed.
Diamond drilling at Gunnar property, Beresford Lake.

1933- Drilling for oil 11 miles south of Manitou.
Vanson mine produces gold.
Grand Central claim producing gold.
Gem Lake Mines in bankruptcy. Property passes to Diana Gold Mines, Ltd.,
1933- San Antonio commenced milling May 1st, and reached 150 tons a day in August.
Production of gold at Ferro claim, Herb Lake, commenced May 19th.
Development work at God's Lake mine.
Island Lake mill operating - August.
Increase in capacity of Oro Grande mill.
1934- San Antonio pays its first dividend, 5 cents a share, March 15th.
San Antonio mine sinking new Main shaft and milling increased to 170 tons.
Gabrielle mine sinking shaft to 400-foot level, April.
Development work at Gunnar mine.
R. E. Phelan, general manager, Hudson Bay Mining and Smelting Company, awarded International Nickel Co., medal.
Mining plant erected at God's Lake mine in operation March 15th and Main shaft sunk to 308 feet.
Island Lake mine producing ore.
Shaft sinking at Gunnar mine.
Operations resumed at Rex mine (now Laguna), June.
Strike at Flin Flon, operations suspended June 9th - July 9th.
Feldspar shipped from Greer Lake.
Operations resumed at Gem Lake mine by Diana Gold Mines, Ltd.,
Employees Welfare Board established at Flin Flon.
Wage scale of 1929 re-established at Flin Flon - September.
Diamond drilling at Forty Four property.
Diamond drilling at Packsack property.
Diamond drilling at Knee Lake - November.
Development work at Wingold property.
1935- Mining plant in operation at Johnston Knee Lake mine.
Mining plant in operation at Knee Lake mine - May.
Hudson Bay Mining & Smelting Co., pays its first dividend.
Diamond drilling at Jowsey Island.
Island Lake mine suspends operations, June 12th.
Discovery of gold at Echimamish River.
Sick Benefit Club started at Flin Flon.
San Antonio increases milling to 275 tons a day.
Gurney Gold Mines, Ltd., purchases assets of Wylie-Dominion Mines, Ltd., August 29th.
Gabrielle Mines, Ltd., sells its property to San Antonio Gold Mines, Ltd.
Hydro-electric power at Kanuchuan Rapids ready for God's Lake mine.
Mill in operation at God's Lake mine- September 1st to Sept. 7th.
Mill in construction at Gunnar mine.
Johnston Knee Lake mine suspended operations, December 24th.
Interest in bentonite near Morden developing.
1936- Mining operations at Knee Lake mine suspended January 18th.
Electric power at Gold Lake mine March 27th, and shaft sinking started April 10th.

1936- Shaft sinking at Packsack mine, April.
Operations renewed at Oro Grande mine - April.
Mill in operation at Gunnar mine, April 17th.
Shaft sinking at Jowsey Island mine but operations suspended July 10th.
Mill in operation at Laguna mine, August 1st.
Capacity of hydro-electric plant at Island Falls increased.
San Antonio increases milling to 325 tons a day.
Diamond drilling at Callinan Flin Flon property.
Diamond drilling at Echimamish property.
Apprentice plan adopted by Hudson Bay Mining & Smelting Co., July.
Dickstone copper discovery near Morton Lake.
Hudson Bay Mining & Smelting Co. increases wages 5 per cent- October.

1937- Bergold Development Co., commences mining operatinns at Cranberry Portage - February.
Shaft sinking renewed at Gurney mine, February 8th.
Century Mining Co., commences sinking at Webb-Garbutt property, Elbow Lake, March 23rd.
Diamond drilling at Dickstone property.
Hudson Bay Mining & Smelting Co. increases wages another 5 per cent - April, and provides for holidays with pay.
"Well Drilling Act", chapter 50 S.M., passed by Legislature.
Sherritt-Gordon mine resumes operations August 1st.,
God's Lake mill increases capacity to 200 tons a day.
Laguna mill increases capacity to 90 tons a day.
Gunnar Gold Mines, Ltd., pays its first dividend - December.

CHAPTER 1.

CONCLUSIONS

Manitoba was first named as a province in 1870. Its boundaries were extended at different times until in 1912 the area embraced included the 251,832 square miles of the present province.

In this vast expanse of territory considerable differences in the nature and topography of the land surface occur. The south and southwestern parts are physiographically the eastern extension of the Great Plains region, characterized by deep soil cover and much open prairie and agricultural land.

To the east, northeast and north the so-called Plains country merges imperceptibly, rarely abruptly, into what is known variously as the Laurentian Plateau, the Pre-Cambrian Shield and the Canadian Shield, part of a vast region which surrounds Hudson Bay and differs from the plains to the west in showing a generally rougher surface, numerous glaciated outcrops of ancient rocks, and innumerable depressions occupied by lakes and muskeg.

Another area, the Hudson Bay slope, for a considerable distance inland from the coast, extending along the lower reaches of Churchill and Nelson rivers, is underlain by flat-lying Palaeozic rocks, is mostly drift-covered and presents a different topographic form from that of the Pre-Cambrian Shield which surrounds it.

More than three-fifths of Manitoba is underlain by rocks of Pre-Cambrian age. The greater mass is made up of granite, granite-gneiss and granite-like rocks. The rocks overlying these have been

[illegible]

eroded and thus the granite and allied rocks are exposed. Some remnants of this former covering are left with the granites and consist of schists derived from the alteration of sedimentary and volcanic rocks.

The known mineral deposits of importance are in volcanics and associated rocks, sedimentary gneisses, intrusive bodies of quartz gabbro and granodioritic phases of the granitic intrusives. As yet the thick-bedded arkose and conglomerate beds have not been found to carry mineral prospects of merit.

So far, in Manitoba, the deposits proved to be of most economic importance are sulphide bodies carrying copper and zinc and some precious metals formed by replacement at considerable depth, and gold veins in rocks which have been intruded by granites. Other types of ore also occur, such as copper-nickel deposits associated with gabbro intrusions and occurrences of tin, molybdenum and lithium in pegmatites.

A general conclusion may be reached that the following metals are possible of commercial occurrence: tin, tungsten, molybdenum, nickel, copper, gold, zinc, platinum group of metals and arsenic. The ~~metals like antimony and lead may appear, but probably in scattered~~ bodies of no commercial value. Mercury is not to be expected except in traces.

As regards gold, the occurrences in western Ontario and northeastern Manitoba indicate that the majority of the discoveries are in basic lava, only a few occurrences being in acid lava, sediments, granite, quartz porphyry, diorite and gabbro. Many deposits, however, are in schist, derived from basic lava, that is cut by dykes of quartz

porphyry, or these dykes occur nearby. The association of gold-bearing quartz and dykes of quartz prophyry is widespread, and hence all schist zones cut by dykes and especially by quartz prophyry, should be prospected very closely. The wide brecciated and silicified zones that carry stringers of vein quartz and sulphides should be investigated thoroughly.

The discoveries made in many of the older gold areas of the Pre-Cambrian in recent years testify to the wisdom of careful and skilled work, so that more detailed prospecting than has hitherto been done in these mineral areas is necessary. In prospecting, the wide schistose zones should first be located and subsequent work limited to a detailed exploration of the belt of deformed rock. Many of the schist zones follow lake basins or swampy depressions for a large part of their length, consequently many of the deposits discovered to date are located along or near lake shores.

A close observation of prospecting in the province over a number of years and a review of the many excellent geological reports would indicate that apart from one or two localized areas the greater part of the known mineral areas has been incompletely prospected, leaving large areas practically unexplored. Prospectors have already discovered hundreds of mineral occurrences in the various known areas of the province. Some of these will become mines. Their further exploration probably lies mainly with the developing mining companies. Many metalliferous deposits have been discovered in the better-known areas, but large stretches of favourable territory which have been explored only to a limited extent still await the prospector.

During the last 20 years some areas have been the scene of much prospecting activity that reacted in an erratic and intermittent

manner to the ability of the prospector to raise money for his endeavours. Many promising showings have attracted attention for a couple of years only to be lost sight of through lack of funds or failure on the part of the prospector to trench into deep overburden or across the entire width of shear zones. Systematic and careful sampling has been lacking on many deposits which might stand up better under careful work. Fractioning of channel samples across many shear zones in some cases gives surprising results and may serve to give the clue to the limits and extent of an ore zone that would otherwise be missed if the entire sample were considered.

The operations at the Flin Flon, Sherritt Gordon, Laguna, San Antonio and Gunnar mines have established the existence of important ore-bodies in their respective localities. The existing gold prices make many of the narrower types of vein deposits exceedingly interesting in this as in many other areas of the Pre-Cambrian.

The discovery of metallic minerals depends to a great extent on the fortunes of the prospector, but such is not always the case with the non-metallic minerals. The extensive deposits of clay, sand, gravel, building stone and stone for the manufacture of cement or lime are more exposed. Located as they are, for the most part, where metallic deposits do not occur, and where building material and other non-metallic minerals are in demand, they have received the earliest attention in this province.

They continue to be an asset of considerable value to Manitoba and are capable of meeting the demands of the building trades or road work. Up to 1927 they were responsible for the greater part of the mineral production of the province, but with the opening of the metallic mineral resources they have been outdistanced by gold,

silver, copper and zinc.

II

It is a moot point how far a government ought to go in aiding and encouraging the development of its mineral resources. The extreme view on one side is that government ought to pursue a course of passivity, leaving the beneficial order of nature free in its operation, while the extreme view on the other side is that the government ought to nationalize the mines and operate them for the good of the people. While it is quite probable that the true policy lies between the two extremes, valuable services may be rendered in at least three ways, namely:

I. Geological Survey, with particular reference to the economic minerals;

II. Collection and publication of yearly statistics of mining and metallurgical industries;

III. Making provision for the education of students to qualify them for geological, engineering and metallurgical pursuits and for the practical instruction of persons engaged in the mining industry;

The Mines Branch cannot carry out the extensive surveys planned by the Geological Survey of Canada, but it should co-operate fully with the Dominion in many details of the work. The service from the Dominion is done in accordance with statute and such surveys are given over to the extent, age, distribution and mineral characters of the different rock formations, as well as to ascertain which formations are probably destitute of useful materials. It should be kept in mind that it is often quite as important for the government and the

public to know what districts and formations are destitute of valuable materials as those which contain them. This can be ascertained only by an intelligent investigation, and such knowledge often prevents disappointment and the waste of large sums of money.

Having learned where and under what conditions valuable minerals occur within the formations, the field of search is greatly narrowed and it is to those narrow areas that the province should extend its efforts in the hope that chances of success may be greatly increased. In this work geology students from the University of Manitoba find useful employment with both the Dominion Geological Survey and with the Mines Branch.

Geological investigation should be carried to a degree that the prospector in the field may avail himself of assistance from engineers of the Branch to check up on the geology of his holdings. Advice, too, can be given as to the best exploration procedure to follow. Knowledge of the geology of the country and of the rocks and minerals and their relation to each other is of obvious advantage to the prospector.

It is recognized that to round off the industrial life of the locality, new resources must be tapped, and to such resources the lands of the Pre-Cambrian area probably hold the key. The intelligent co-operation of all people in the province is, therefore, necessary to this development.

III

Mining today demands special training. It has become highly technical in all its branches and the technology of the industry is always progressing. In order that the mineral resources may be successfully and economically developed, measures should be taken for the practical and scientific training of all who may engage in the industry.

For the training, several universities in Canada have separate departments for ming and metallurgical work. Manitoba has no such training nor does it appear at this time that the University would be justified in the expenditure necessary to offer a course in mining engineering. However, the mines of the province continue to use young men with technical training and there is no reason why many of these men cannot complete that training in the presently established universities which offer courses in mining training. To offset the expenditures required here and yet to provide the necessary training for its young men who are to go ~~to technical~~ positions at the mines, could not the mining companies now operating with success in Manitoba be prevailed upon to offer scholarships for Manitoba students pursuing mining in Canadian Universities. Such training would only require the last two years of the four-year course as the preliminary work may well be done at the University of Manitoba. With the University of Manitoba now offering a course in geological engineering, the training of its geological students will now take on a more practical advantage.

Another responsibility in the training of its young men devolves upon the mining industry in Manitoba, for many boys are

growing up in the mining communities who would like to follow their fathers in mining work. At the Flin Flon mine an apprentice plan has been adopted and boys from the town are taken into the plant in various capacities. The apprentices have to be sons of employees.

IV

It is gratifying to mention that relations between employers and employees at Manitoba mines have now continued for some years along mutually satisfactory lines. With prices of base metals falling to unprecedented low levels, the Hudson Bay Mining and Smelting Co. Ltd., was forced to cut wages at Flin Flon below the 1929 schedule. The full wage, however, was restored by 1935 and further increases in pay up to 10 per cent above the 1929 level are now in force.

The pleasant relations that have prevailed have been further strengthened by the institution at several mines of vacations with pay, the time of holiday dependent upon the length of service of the employee. When this plan became effective at the San Antonio mine, it was found that of the 180 men on the payroll, 80 per cent were eligible for vacation. Group insurance, too, has been adopted at some of the mines.

V

In a report given in an Economic Survey of the U.S.A., the following statement is made:

> "Mineral reserves are unequally distributed among the nations. No one nation has a complete supply of the minerals necessary for modern industry. The principal sources of supply are relatively few as compared with the nations to be served. The

> "world's supplies of most minerals are so large that there is little need for concern about early exhaustion, but for each nation there is danger of early exhaustion of particular minerals. Hence the necessity for the orderly development of these resources by persons qualified by knowledge, skill and financial strength."

This statement applies with equal force to the mineral resources of any country.

In the matter of an Economic Survey of the mineral resources of Manitoba, one must, of course, recognize that this province is a part of a greater Dominion and in the final analysis the mineral resources of the province must be considered in the light of its being a member of Confederation.

The consideration of such questions as,-

Estimate of future consumption of minerals;

Curtailment of excessive production;

Conservation of resources;

Effect of mineral tariffs;

must of necessity be matters for Federal action, but nevertheless the province of Manitoba has some concern in these matters, particularly as such metals as copper and zinc, gold and silver are concerned. There should be then a relationship between federal and provincial policy.

The metals mentioned are those which Manitoba has in excess of its requirements and the same may be said of the production of these metals throughout Canada. For the present we have a surplus. On the other hand, there are minerals vital to our national welfare which do not occur in any part of Canada, and there are, too, minerals found in Canada which do not occur in Manitoba. We have then both foreign and domestic relations to consider.

Further, we should ~~should~~ not lose sight of the fact that minerals are not inexhaustible. All too frequently, careless statements are made of mineral resources and little thought is given to a matter with which the world should be intensely concerned - minerals once extracted are non-reproducible. Neither has the engineer yet devised methods which will permit of the extraction of all the values contained in an ore. When it is reported there there is gold to the value of $10.00 in a quartz ore, it does not necessarily follow that the full amount can be extracted. The value of an ore shown by chemical analysis is not necessarily that recovered in the milling. The company is very fortunate which makes a 98 per cent recovery. In the case of the base metals the recovery is considerably below this. The economics of metallurgy are such that the cost of extracting the final small percentage is frequently greater than the value of the metal that could be recovered.

Having regard to these questions, as well as to the special risks both physical and economic in mining, it is quite clear that in the interests of both provincial and national welfare, due consideration should be given to the orderly and efficient use of our minerals in order that there shall not be undue waste of the physical resources.

Mining has many features which distinguish it from other industries. The exhaustibility of minerals has been mentioned and, while the exhaustion may not come in the near future, the industry is faced with greater costs as mines increase in depth, or ore-bodies in lower grade or greater complexity. Secondly, mineral lands generally have little or no value for other purposes than mining. It would be difficult to conceive of other industries thriving at

Flin Flon without the mine in operation. With the closing of the mine, the community soon passes out of existence.

In metal mining particularly, a collapse of prices has at times forced operators to abandon low-grade mineral. On the other hand, gold mining has been greatly increased by the enhanced price of that metal since 1934. The operator informed of the sub-marginal areas in his mine will turn to those when prices increase. In fact, he will mine such areas to better advantage than when he has, on account of falling prices, to turn to the better-grade portions of the mine. However, for economic stability, a steady production is most desirable.

VI

In the past, great credit has been given to the prospector, the pioneer of the mining industry. His work made possible the industry of today. While it is admitted that the examination of mineral areas is as yet incomplete and to a large degree superficial, signs are not wanting that the discovery of surface outcrops is becoming a more difficult problem than it was. The extent of the mineral regions are fairly well known, but in so far as the Pre-Cambrian areas are concerned, much of it is covered with overburden and lakes. If these areas are to continue to produce as they have in the past, more discoveries will have to be made and it would appear that in order to do this, science will have to come to the aid of the prospector.

VII

In summarizing the conditions which have worked to Manitoba's favour in the growth of its mining industry, the following factors have had a decided effect in stimulating that growth:

1. Advances in the flotation process, making treatment of Flin Flon and Sherritt Gordon ores a commercial success;
2. Hydro-electric power - at low cost, and plenty of it;
3. Development of the tractor for winter haulage;
4. Aeroplane service - the year round;
5. Base metal producers came into being before the depression;
6. Increase in price of gold from $20.67 to $35.00 an ounce;
7. Good labour available within the province;
8. Abundant supply of timber and water for mining and milling purposes.
9. Mineral exposures lend themselves to ready appraisal by the prospector or examining engineer due to shallow weathering.

The first metallic production recorded for the province was in 1917 when the value reached $318,287, made up of gold, silver and copper.

The year 1937 was the best in the mining history of the province with metallic production valued at over $14,000,000. Gold, silver, copper, zinc, cadmium, lead, selenium and tellurium were extracted from Manitoba ores. The greater part of the production has been obtained from the Flin Flon and the Sherritt Gordon mines, but gold mines at Beresford Lake, Bissett, Herb Lake, Copper Lake and Gods Lake have made a considerable contribution to the gold and silver. The non-metallic production for the year is estimated at $1,767,669.

THE MINING INDUSTRY OF MANITOBA

The Province of Manitoba is relatively young in the mining industry, yet the growth of the industry has been steady and sound.

CHAPTER 2.

HISTORY OF MINING IN MANITOBA

In Manitoba during the past twenty-five years, there has been a steady development of a new industry, the mining industry, and now particularly as it concerns the metallic minerals yielding gold, silver, copper and zinc. Earlier work on the mineral resources of the province was confined to non-metallic minerals. This was to be expected in an area where the population, dependent on agricultural lands where metallic deposits did not occur, sought for building material and other non-metallics.

From the time when the production of gold, silver, copper and zinc was added to that of salt, limestone, clay and gypsum, the mining industry has grown steadily. Today it has assumed proportions not dreamed of some years ago, unless by the enthusiastic geologist who, having made exploratory trips to what was a northern wilderness, returned to report favourably of its natural resources. Such an explorer was J.B.Tyrrell who travelled in northern Manitoba for the Geological Survey of Canada in 1894. Some years later, or in 1916, Tyrrell again paid a personal visit to the north country and wrote the following for the Bulletin "Northern Manitoba", July, 1917:-

> "The people of Canada have begun to realize that there is in northern Manitoba a great country which is worth exploring and developing for the natural resources which it contains. The country is just at the dawn of its development, and in the next twenty years it will doubtless progress at a rate unknown in the past. If I should be alive twenty years hence and should have the good fortune to be able to re-visit this country which I have watched from its economic birth, I shall confidently expect to see its towns and villages which will be centres of profitable mining industry and also a prosperous farming community".

Manitoba is fortunate in having within its boundaries many of the mineral materials which are necessary in the arts, in industry and in finance. In the development of its mineral industry, new markets, new money, new employment and new homes have been created. With the growth of the mining industry, people of this province have benefited materially in finding a livelihood where they could not do so before. Indirectly, there has been growth and expansion in the other industries of the province--agriculture, lumbering, transportation and power development, owing to the impetus given by the mining industry. In Manitoba, as in Canada, the mining industry, in the lean years through which Canada has passed, has helped greatly in its contribution to transportation and in the pay-rolls provided.

The first explorer to visit the coast of Manitoba was Henry Hudson, who, in 1610, made his ill-fated attempt to find the answer to the question of the northwest passage. In 1612, Button, searching for Hudson, entered the Nelson River; in 1619 Munck, a Danish explorer entered Churchill River. But when in 1670, Charles II ceded the country around Hudson Bay to the Hudson's Bay Company, the primary interest in the interior of Canada centred in the furs.

Other explorers and traders came from the east by the Great Lakes. In the vanguard of the large company of traders using this route was La Verendrye, an explorer searching for the northwest passage, who reached the present site of Winnipeg in 1732.

From the seventeenth to the closing years of the nineteenth century, northern Manitoba was pre-eminently a fur-producing territory. Trader, Indian hunter and trapper held undisputed possession. The positions of the trading-posts and the trade routes connecting them were known only to the traders themselves and their guides.

Despite the fact that historic trade routes lay within this northern territory, at the time of the extension of the province, there had been comparatively little travel for the purpose of discovering mineral wealth apart from the main waterways. True, tales of copper in the far north had been heard for many years by the officials of the Hudson's Bay Company at York Factory and Churchill. Governor Norton persuaded the company to send Samuel Hearne in 1768 on his memorable journey to the Copper Mine River. Dr. Brown, a surgeon at Churchill, in his evidence at an enquiry, told of finding red earth 36 miles south of Churchill River, which reacted like cinnabar. The company, engaged in a lucrative fur-trade, was not attracted to a new enterprise of a somewhat uncertain character, and gave no support to mineral exploration in the north.

In the year 1870, Manitoba became a province of the Dominion of Canada, and until 1912 was, on account of its geographical shape, referred to as the "postage stamp" province. In the latter year the boundaries of Manitoba were extended northward to reach the 60th parallel and northeastward to include the southern portion of the old district of Keewatin and to intercept Hudson Bay in longitude 90 degrees. Today, Manitoba has an area of 251,832 square miles with a great stretch of ocean frontage on Hudson Bay.

Much of this newly-acquired territory known as northern Manitoba, did not offer the agricultural possiblities obtained in the southern portion of the province. However, there is throughout this northern area, particularly in the valleys of the rivers, much rich, alluvial clay that can support agricultural settlement. Thus, a virgin soil lies within the borders of the Pre-Cambrian Shield (to be referred to under "Geology of Manitoba"), which for the most part is a rough,

rocky, forest area broken by myriads of streams and lakes. This large territory, more difficult to travel and less hospitable than the plains country to the south, was for many years regarded as a fur country, capable of supporting a comparatively small number of trappers and the scattered posts of the great fur-trading companies. The importance of this large Pre-Cambrian area as a mining field was not at first recognized.

The southern portion of the province, due to its position and nearness to the Canadian Pacific Railway, attracted the attention of prospectors early. The stimulus which successful gold mining in northern Ontario has given to Canadian mining since 1910, had a marked effect on exploratory work in Manitoba. Transportation difficulties, which for many years hampered the prosecution of development work in Manitoba, have in recent years been overcome by the aeroplane and the tractor. With changing conditions, one readily forgets how serious were the difficulties that the pioneers in development had to face before they could obtain anything satisfactory in the way of transportation facilities.

The story of mining in Manitoba should start with the non-metallic minerals, as they had priority in development and in the production tables. The non-metallic industry has been in process of growth since the days that the Hudson's Bay Company began back in the early years of the nineteenth century to extract salt from the brine springs on the west side of Lake Manitoba and Lake Winnipegosis.

From 1800 to 1876, and probably at a still earlier date, freed men from the Hudson's Bay Company service, and, in the early years employees of the North-west Company evaporated the brines from the springs

in iron kettles or troughs to supply salt to the trading posts from Norway House to Fort Qu'Appelle and to the Red River settlement. In the years prior to 1874, more than 1,000 bushels were manufactured annually at Monkman's Springs. The product was reddish in colour and deliquescent, but met the needs of the district until the railway brought in salt from Ontario.*

Gypsum was first reported as occurring in the province by J. B. Tyrrell, in 1889. In the late nineties the gypsum deposits northwest of Lake St. Martin were opened up and the calcined product was conveyed by boat from Old Gypsumville on Lake Manitoba to Totogan and thence to Winnipeg. The route now from the sources of supply at Gypsumville and Amaranth to calcining plants at Winnipeg are all rail from which the present market in the prairie provinces is served.

Clays are widely distributed over the surface of Manitoba. As early as 1886 four brick plants were operated in Manitoba and by 1910 these had increased to 26, when the peak of production was reached in the province. Many plants ceased operation during the Great War.

The history of the cement industry in Manitoba dates from 1904 when the first mill was erected at Arnold, 70 miles southwest of Winnipeg, for the manufacture of natural cement. Another natural cement plant was established at Babcock, west of Roseisle, but both of these plants have ceased operations. The first Portland cement plant was erected in 1921 at Fort Whyte, a few miles southwest of Winnipeg.

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* "The Mineral Resources of Manitoba", by R. C. Wallace, 1927, Ind. Dev. Bd. of Man.

In fuels, the history of development has been slow. While the coal deposits of Alberta were yet untouched, considerable interest was shown in the lignite seams which were known to occur in Turtle Mountain in southwestern Manitoba. In 1888, the Manitoba Coal Company, Limited, was incorporated to mine and extract coal from beds located in the Turtle Mountain area. This was followed in gypsum in 1889 by the Western Plaster Company, Limited, which later changed its name to the Dominion Gypsum Company, Limited. During the nineties of the last century, mining was done on the northwestern flank of the mountain at the old McArthur mine, and at the Valen mine. Following this for some twenty years no lignite was mined in the area. The opening of the Estevan field, from which the first coal was brought down Souris river by barge, has made available a lignite area of much greater extent and more feasible exploitation. The Turtle Mountain area can serve some local demand.

Interest was next shown in prospecting and boring for oil, coal and salt in Manitoba, the Nelson Prospecting and Mining Company, Limited, being incorporated in 1884 by "residents of the village of Nelson, in the County of Dufferin."

In 1887, the Manitoba Oil Company, Limited, bored to a depth of 743 feet in an endeavour to find petroleum along the Vermilion river, on section 23, township 23, range 20. This well was located some nine miles south of the town of Dauphin.

In many places drilling has been carried on for oil and gas. At Waskada in southwestern Manitoba and at isolated wells elsewhere in the province, natural gas has been found in quantities sufficient for local use but no occurrences yet encountered have been of such consequence as to make the gas available for wider distribution.

Mining activity ceased until 1897 when the world went wild over the riches of the Yukon. Thoughts of the mineral possibilities of Manitoba were again brought home to the people of this province, and four companies were formed for mining development, mainly within the province of Manitoba. These were followed by two in 1898, one of which had its head office at Portage la Prairie, and three in 1899, one with its head office at Gladstone.

The history of metalliferous mining in Manitoba lies within the past 28 years. Some prospecting had been done before 1910 in the northern areas of the province, but development work really dated from that time. People in this province had, as early as 1879, been interested in the gold discoveries of the Black Hills of South Dakota. In turn they were interested in the discoveries made in the Lake of the Woods region and the first record of any mining company organized in Manitoba is that of Winnipeg Consolidated Gold Mining Co., Limited, incorporated September 2nd, 1882, to carry on mining operations at or near the Lake of the Woods. In the following years, 1883 and 1884, a number of companies organized to operate in the same region.

From 1899 to 1912, the lack of interest in mining was reflected in the formation of few companies. The stimulus necessary to further mining seems to have been dependent to a large extent on the interest in the neighbouring province of Ontario. The Lake of the Woods mining boom in the late nineties of the last century caused the prospecting of some small adjacent parts of Manitoba. The importance

of the large Pre-Cambrian areas, however, was not recognized until the great discoveries of Cobalt and Porcupine early in the present century aroused keen interest in the possibilities of the entire north country.

Almost over night, as it were, there came a general realization that the non-agricultural areas constituting the greater part of the province could make great contributions to the annual wealth of Manitoba. The reports of early explorers, the comments of surveyors, water-power officials, geologists, trappers, Indians and others all combined to change the viewpoint of the people of this province, and, as a result, the resources of the non-agricultural areas in products of mines, forests and water were subjected to investigation heretofore unconsidered.

While many of the early explorers give considerable space to the descriptions of mineral occurrences, practically all the detailed investigations were carried out by officers of the Geological Survey of Canada, to whom also, and to the land surveyors of the Department of the Interior, all the mapping of the district which has yet been completed is to be credited, with the sole exception of the coast line of Hudson Bay. Through the work of J. B. Tyrrell and Wm. McInnes of the Geological Survey of Canada, areas north and west of The Pas were examined, and the possibility of mineral deposits was indicated before actual discoveries were made. E. L. Bruce, F. J. Alcock and J. F. Wright of the Geological Survey followed after 1920 and were responsible for considerable of the detailed mapping in the mineral belts.

It is well to recall at this time that among the provisions made in the Manitoba Act, 33 Victoria, and assented to May 12, 1870, for the establishment of a government for the province of Manitoba, there is one

affecting geological work in Manitoba. Frequently emphasis is given to the same provision made for the province of British Columbia when it entered Confederation in 1871, while many have lost sight of the fact that by act of parliament the Dominion of Canada has the same responsibilities for geological work in Manitoba as it has in British Columbia.

Section 26 of the Manitoba Act reads in part:

> "Canada will assume and defray the charges for the following services:
>
> (7) geological survey."

Manitoba, at its entry into Confederation, has not been so insistent as British Columbia on the carrying out of this arrangement. This may appear a natural course where the people of Manitoba have not had the value of mining brought home to them so insistently as it was in British Columbia. Manitoba began as an agricultural province, while British Columbia owed its opening up and settlement to mining.

With a changing attitude on the part of the people of Manitoba and the belief that the province had mining possibilities hitherto unconsidered, there came an urgent demand for more geological work in the province in accordance with the provision in the Manitoba Act. Geological investigation and mapping of the province has been carried on by the Dominion government since the late seventies of the 19th century, but within recent years more intensive and detailed work has been undertaken by the departments now merged into the Federal Department of Mines and Resources.

The early prospecting in the mineral belt around The Pas is vividly described in the following, a communication[1] from Hugh Vickers of Herb Lake, Manitoba, who can claim the honour of having prospected the territory for a greater number of years than any other man in the country.

> "The first expedition having for its object the search for minerals in this district, of which I have any knowledge, was in 1896. In this year a Mr. Loucks, who was farming near Prince Albert, made an expedition as far as Reed Lake where he staked a claim, which assayed $9.00 in gold. About this time the discoveries in the Yukon drew most of the more adventurous prospectors in that direction.
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> "No more interest seems to have been taken in this district until the discovery of ores containing copper at Lac la Ronge in 1907 or 1908, though some parties may have made trips that produced no results. I think, however, that it was before this date that an American company attempted to work the amber deposit on Cedar Lake. At this time most of the supplies for Cumberland House, which was the headquarters of the Hudson Bay Company were floated down the river from Prince Albert in 'flat-boats', roughly built scows which were broken up for the lumber at the end of the trip, or brought down by the steamer 'Saskatchewan' which was built about this time.
>
> "The first two trips I made myself were both from Prince Albert. In the first year I made a trip to File Lake, and in the second staked some claims on the Copper Lake sulphide deposit.
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> "It must have been about this time, i.e. 1908, that Brunne (after whom the lake adjoining Copper Lake is named) came to the country, and it was in the same year that I met Richard Woosey and Charles Krug coming in from a prospecting trip, at which is now Sturgeon Landing.
>
> "In those days the chief difficulty of prospecting lay in the fact that it took so long to get in and out of the district. Though the steel was laid from Hudson Bay Junction to The Pas (which was then known as The Pas Mission) the track was only ballasted for eighteen miles and no trains were running, the usual method of travel being by hand-car.

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1 To R. C. Wallace, Principal of Queen's University, Kingston, Ontario formerly professor of Geology, University of Manitoba, and for a time Commissioner of Mines for Manitoba.

"I retain a very vivid recollection of a trip with a scrip commission under 'Big Bear' McLean. We took three days to reach the Junction and had to send in one of the hand-cars from twenty miles out to obtain more hand-cars, as the ones we had were falling to pieces. The cars we got were not in much better shape, but under the able superintendence of Dr. Stewart of Saskatoon, who was attached to the script party, we finally evolved two fairly serviceable machines and finished our trip safely. I remember also that when were were almost out of grub, Dr. Stewart beheaded eleven prairie chickens with twelve shots from a .303 rifle.

"It was in 1908 or 1909 that I first met Billy Todd(on Beaver Lake), who prospected and trapped for some years, and was drowned in the Grassy River. Dan Mosher and (I think) Jack, also made a trip about this time, and one or two parties came down from Lac la Ronge by way of Stanley, Frog Portage and Pelican Narrows.

"Woosey, Krug, Brunne, Todd, Rod McLeod and myself stayed in the country from Beaver Lake to Little File Lake, and in the following year made a trip from The Pas to Split Lake with W. B. Wright, going in by Cumberland and coming out via the Metati River and Moose Lake.

"This trip was financed by Messrs. Hammond and Burroughs of the Canadian City and Town Properties, Limited, who, as far as I know, were the first parties to go to any considerable expense to explore the country. It was in this year that George Bancroft brought a party from Porcupine to prospect and since then there have always been several parties in the field.

"I might mention that in the early years it was an extraordinary event to meet anyone in this district in the summer except on the Hudson Bay Company freight routes, i.e. Sturgeon River or the Nelson. All the Indians were at or near the posts or working on the York boats until after the treaty payment in the fall when they would begin straggling off to their winter trapping grounds. W. B. Wright and myself travelled 44 days (from Sturgeon River to Split Lake) without seeming a human being.

"Jacob Cook and Philip Keddie of Cumberland accompanied me on most of my early excursions, and their knowledge of the country was invaluable."

In passing, a comparison of the early and the modern days insofar as travel is concerned may be made. When J. B. Tyrrell made a trip of exploration in northern Manitoba in 1896 for the Dominion

government, he had but one serviceable map, one made about a hundred years previously by David Thompson, a fur trader of the old Northwest Company.

Today the prospector entering that field may obtain without difficulty[1] any of the excellent series of National Topographic maps which have been compiled mostly from aerial photographs on a scale of four miles to an inch. Each map embraces the area contained between consecutive latitude circles one degree apart (north and south) and between meridians of longitude of even number, i.e. two degrees apart (east and west). Each map covers an area of approximately 80 miles east and west by 68 miles north and south.

In point of time, southeastern Manitoba is the oldest mining area of the province but prospecting has been intermittent. As early as 1896 a few prospectors entered the field and some claims were staked, but it was not until 1911 that any discovery of consequence was made. Any history of prospecting in Manitoba without a reference to the work of E. A. Pelletier would be wanting in the romantic which adds interest to accounts of prospecting. Resigning his commission in the Royal Northwest Mounted Police in May, 1910, he turned his attention to prospecting in Manitoba, and with A. C. Gray of Regina spent the months of June and July in areas north and east of Norway House.

After this time Pelletier, now working alone, was attracted to areas south of Norway House, and while enroute south by boat, he met Chas. A. Bramble, who was assocated with Great Northern Gold Mines, Ltd.[2]

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1 Available at mining recorder's offices in Manitoba for a small charge.
2 This company held a number of claims adjoining the Hole River Indian Reserve to the southwest and also to the east. The claims were staked by Arthur Quesnel, Chas. A. Bramble, Louis Simard, Allan Meade and John Potvin, and were assigned to Great Northern Gold Mines, Limited.

of Selkirk, Manitoba, a company incorporated in 1908 and holding property at the mouth of Wanipigow (Hole) River on the east short of Lake Winnipeg. Bramble told Pelletier of favourable geological formations in this area. Leaving the boat at Hecla, Pelletier proceeded by canoe to the mouth of Wanipigow River and explored as far as the east end of Wanipigow Lake. Next he proceeded to the mouth of Manigotagan River and was welcomed at the trading post of Arthur Quesnel who told of the mineralized areas along the river.

It was not long before Pelletier had discovered gold near the mouth of Manigotogan River, whereupon he staked the Ojibway mineral claim, August 25, 1910. Proceeding to Winnipeg, he recorded the staking and organized the Ojibway syndicate with the cooperation of friends at the Military Institute, Winnipeg, for the purpose of mining development. Included in the Syndicate were F. L. Cartwright, F. L. Cosby, A. C. Gray, John Ketchen, W. A. Munro, J. W. Sifton, W. L. Roblin, G. F. C. Poussette and A. M. S. Ross.

In September, 1910, Pelletier returned to work the claim with Alex. Desautels of St. Boniface, who could speak the Cree language. Taking with him mineral samples which he had obtained at Montreal, Pelletier instructed the various trappers what minerals to look for on their hunting trip and also indicated what regions appeared favourable for the occurrence of gold. After freeze-up in the fall of 1910, Pelletier travelled east along Manigotagan (Bad Throat) River with Alex. Spence, a trapper, and, meeting at Turtle Lake with Duncan Trueheart, an Indian trapper, they learned that he had some rock samples in his possession. Only one of these, a piece containing some arsenopyrite said to have come from somewhere in the vicinity, proved of interest. The Indian was attracted by the samples Pelletier carried

and said he would keep on the lookout for gold quartz similar to what was shown him.

Pelletier and Spence proceeded to Big Rice Lake where the latter had a winter camp at what later was the location of the Rachel mineral claim. The favourable nature of the rock formation along the lake was noted by Pelletier. About a month later he was again at the Ojibway claim. In the meantime, Trueheart had sent a parcel of rock samples to Arthur Quesnel. One of these samples, done up in a piece of blue overall cloth, appeared to Pelletier to be of particular importance. Plans were made to investigate where it came from and at the same time an agreement was reached regarding the division of interests in the claim, if it proved worth staking, between Pelletier's Syndicate, Quesnel and Trueheart.

As Quesnel could not leave, it was arranged that Johnny Woods, who could speak both Cree and Salteau, should go. A start was made from Manigotagen with two dog teams. At Turtle Lake the sample of quartz wrapped in the blue cloth was shown to Trueheart who answered through the interpreter, Johnny Woods, "Big Rice Lake". The Indian and his son, with another dog team joined the party which proceeded to Big Rice Lake. They stopped a mile west of Spence's camp on the north shore of the lake. There Trueheart pointed out where the sample had come from, but nothing could be seen except a few pieces of float quartz.

As Pelletier was desirous of finding an outcrop of rock, he immediately gave instructions to gather wood to start a fire. The dogs were unhitched and tied; snowshoes were taken off and used to

shovel the deep snow from a large area. While the fire was melting the snow and ice, thus exposing bedrock, the usual bush lunch was prepared. When the rock outcrop had been bared and strongly heated by fire, Pelletier directed that water be thrown on the rock. This caused the quartz to break off in slabs and exposed an unweathered surface of quartz and sulphides which, on closer scrutiny, showed visible gold. Then followed the staking of the Gabrielle mineral claim on March 6, 1911, by E.A.Pelletier.

In a short time, equipment was moved from the Ojibway camp to the Gabrielle claim. Preliminary development work was carried on by Pelletier and one assistant, Alex. Desautels. Two more claims were staked - the San Antonio claim on May 17th, 1911 by Alex. Desautels, and the Rachel claim on May 18th, 1911, by E.A.Pelletier.

With open water in the spring, Pelletier went to Turtle Lake, where Trueheart made for him a birch bark canoe in which, with the assistance of Desautels, several hundred pounds of samples were taken to Hecla and thence to Selkirk by a fishing boat.

Realizing the importance of the discovery and the necessity of adequate financial support, Pelletier left immediately for Montreal where, through the assistance of A.A. Pare', mining engineer, the claims were offered to the Timmins Brothers (Noah and Henry) of the Hollinger mine. Later Pare' and Jules Timmins came to Manitoba to examine the properties - then a long way from the railway or other ready means of transportation. At the time of the examination, about July 31, 1917, some claims were staked by Pare' and Timmins. However, the deal with the Timmins Brothers did not materialize, as Pelletier was averse to the obligation of all three discoveries on the Gabrielle,

San Antonio and Rachel in one venture.

Convinced of the possibilities of the new Manitoba mining area, Pelletier had enlarged the Ojibway Syndicate and incorporated it with the name of Gabrielle Gold Mines, Limited, on June 9, 1911, with capital of $100,000. The Gabrielle claim was assigned to the company September 20th, 1911. With the failure to obtain support in the east, stock of the company was offered in Winnipeg at 30 cents a share--the first to be sold for a development in the Rice lake area.

In discussing the venture of those days and the first advertisement in the Winnipeg Free Press of a Manitoba gold mining stock, one who remembers the events of those days says:

> "The sale of this stock by Fryer and Company caused considerable comment and much ridicule in Winnipeg, but there were a few so-called unbalanced people who with stealth and abandon bought a few shares--from 50 to 100. But those purchasers did not want their names used or their friends to know that they had come to such a low level of financial hopes. However, the conservative statements of this first gold mining advertisement created interest as well as smiles. To strangers in Winnipeg the statements appeared of marked importance."

And now a new chapter in the mining history of Manitoba was being written though the Pelletier claims on the shore of Rice Lake were yet many years removed from a producing mine.

Following the discovery of gold at Rice Lake, many claims were staked in the area. Then came several years of fitful attempts at development in this area, during which no prospect made a mine. Results so unsatisfactory cast doubt on the presence of gold in paying quantity.

SAN ANTONIO GOLD MINES LTD.
MILL *and* NO. 3 SHAFT
Photo by Geological Survey of Canada

It was not until Central Manitoba Mines Limited began milling operations in the fall of 1927 that a steady production has come from the area. The property of this company is located approximately 125 miles northeast of the city of Winnipeg and some 4 miles northeast of Long Lake. The original development work on the claims was done by the W. A. D. Syndicate, composed of Henry W. Wentworth, T. Cuthbert Anderson and Howard Clark Davis. Two major ore shoots were disclosed along what was called the W. A. D. zone, the first shoot on the Kitchener and the second 3,500 feet to the east on the Hope claim.

Although the Central Manitoba mine and mill operated continuously from 1927 until the middle of 1937, its career has been overshadowed by the successful operation at the San Antonio mine, 22 miles west of Central Manitoba mine. The San Antonio, located on the north shore of Rice Lake, marks its origin in the discovery made by E. A. Pelletier and associates early in 1911. The history of the San Antonio mine forms an interesting chapter in the mining development in Manitoba. It was not until 1926 that active exploration was started by the Wanipigow Syndicate (F. M. Connell, Toronto, Ontario, with Chadbourne & Thompson of New York). On July 26th, 1927, Wanipigow Mines, Limited, was incorporated with a Dominion of Canada charter. In turn the company's name was changed to San Antonio Mines, Limited, taking that name from one of the principal claims of the group held at Rice Lake. Later, the company changed its name to San Antonio Gold Mines, Limited, incorporated July 31st, 1931, in the province of Manitoba.

In the development of the San Antonio property, three names stand out--J. D. Perrin, now president of the company, as promoter of the project, D. J. Kennedy as manager of the company and its operations; John A. Reid, consulting mining engineer, of Toronto Ontario. The position of the company today is the outcome of faith in the venture, efficient direction of its development and the accurate deductions from geological study.

The San Antonio mine began production of gold in 1932, milling ore at 150 tons a day. When in 1934 it paid a dividend, it became Manitoba's first dividend-paying gold mine. Operating since 1936 at a capacity of 320 tons a day, it has successfully completed the year 1937 with higher ore reserves than at any time in its history.

In May, 1936, a new gold producer, the Gunnar Gold Mines, Limited, in the Beresford Lake area, was added to the list and brought to light another example of what may be done by prospecting old workings. Here the ore-bodies are adjacent to or along old workings which, had they in the first instance, been prospected more thoroughly, would have yielded mines at least five years sooner. The Gunnar, too, has joined the dividend-payers, having now returned 6 cents a share in two dividends to its shareholders. In the discovery and opening up of the Gunnar property, the names of William Walton, Gunnar Berg and Leo Soaborg are intimately associated.

Though southeastern Manitoba may claim the first areas recording early discoveries of gold, it cannot claim the distinction of being the first gold producer. While isolated occurrences were known at an earlier date, the first systematic search began in 1907 in the area north of The Pas, and now usually referred to as The Pas mineral belt, culminating in the discovery on the Kiski-Wekusko group

of claims at Herb (Wekusko) Lake in 1914. The first recorded production was that for 1917 when a shipment of 28½ tons of gold-quartz ore was made from the Moosehorn claim at Herb Lake to the smelter at Trail, B. C. The returns amounted to $2,323, mostly in gold, and yielding an average of $81 to the ton.

The discovery of gold at Herb Lake in 1914 and of copper ore at Flin Flon Lake in 1915 quickly attracted attention to the possibilities of northern Manitoba.

The Flin Flon ore-body was the first discovery in the area. The story of its discovery has its romantic side, and how it got its name is a matter of historic interest. The details as prepared by A. J. McLaren, consulting engineer, Winnipeg, and formerly Inspector of Mines and Resident Engineer with the Mines Branch of Manitoba is as follows:

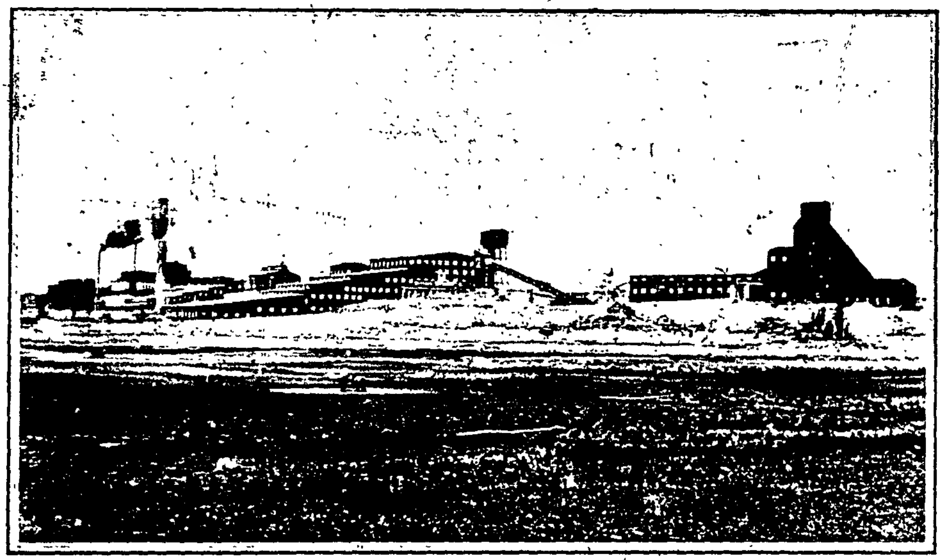
> "The find was made in the winter of 1914 just before Christmas by Thomas Creighton who had a camp at the time on Phantom Lake, a few miles south of Flin Flon Lake. He was one of a party of six men prospecting in the Amisk (Beaver) Lake area for John Hammell and associates of Toronto, Ontario. Four of the party, Creighton, Leon Dion, and the Mosher brothers, Dan and John, combined trapping in the winter and prospecting in the summer. Dion was camped in the neighbourhood and the Mosher brothers near Amisk Lake.
>
> "On the day of the discovery Creighton was circling through the country looking for fur signs, sizing up the rock formations and hoping to see a moose that he could shoot for fresh meat. His wanderings took him in sight of a lake (there were then no maps of the country) and he went down to its shore. On a point where there was an outcrop the snow had been blown clear enough to show chalcopyrite in the schist. Creighton saw the mineralization and decided that it was worth further investigation.
>
> "When the snow was gone in the spring of 1915, he returned for that purpose in the company of John Mosher. Together they decided the prospect was worth staking and on August 15th, 1915, after a further examination they

" staked the first two claims on a weathered gossan which panned values in gold but was soon found to be primarily a copper-zinc-sulphide deposit. They then went to Beaver Lake where the other members of the party, Dan Mosher, Dan Milligan and the Dion brothers, Isidore and Leon, were located. After staking sixteen claims, Hammell was informed of the discovery. He examined the property and subsequently interested Hayden-Stone, Boston, Mass., and associates, with the result that exploration work, including diamond drilling was soon under way.".

Since that time the Flin Flon ore-body has been at different times and by different interests subjected to careful investigation. It was in 1920 that R. E. Phelan, later to be general manager of the company which took over and operated the property, came to Flin Flon to study a direct smelting of the ore.

In November 1925, the Whitney interests of New York, with R. H. Channing, Jr., negotiating for them, optioned the property. When this option was exercised, the Hudson Bay Mining and Smelting Company, Limited, was incorporated and the financing of the enterprise to operate the Flin Flon mine was carried through successfully. That the company has come to its present condition is, for the most part, due to R. H. Channing, Jr., and R. E. Phelan.

As the question is frequently asked: "Whence the name 'Flin Flon' for the mine?", the answer at this time will be of interest. It was derived from a character, Flintabatty Flonatin, in a book "The Sunless City", by J. Preston Muddock, which had been found in 1913 by Creighton, Leon Dion and the Moshers while travelling a portage from Churchill River to Lac la Ronge in Saskatchewan. Reading matter in the wilds was not at all plentiful at the time so the book found a resting place in the care of the prospecting party. It was read and re-read. The leading character was now almost a member of



HUDSON BAY MINING & SMELTING CO., LTD.
FLIN FLON

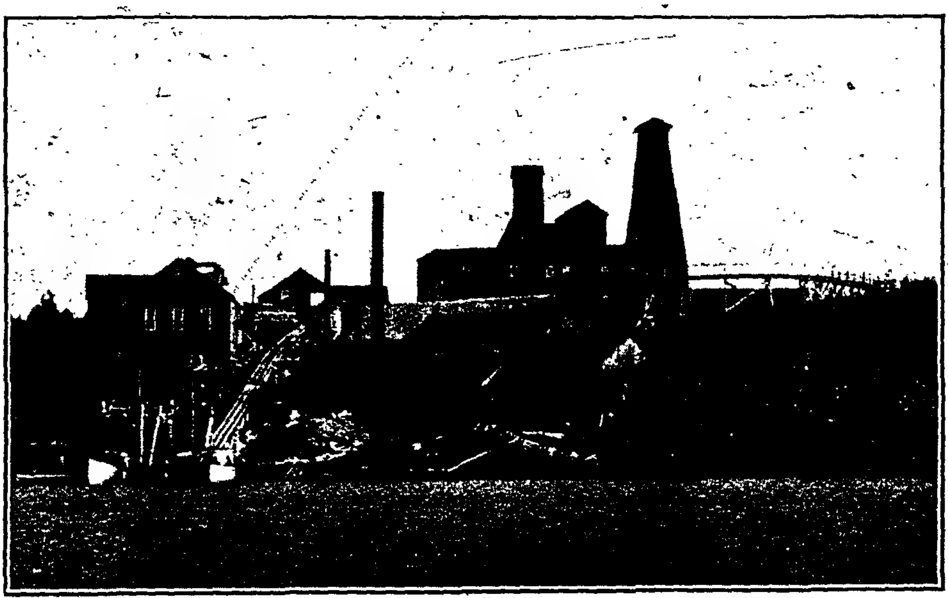
1915, is known as the Mandy and is located on the small peninsula on the west side of the northwestern arm of Schist Lake.

In the years 1917 to 1920, 25,000 tons of ore, averaging $91 per ton in recoverable metals, were mined, hauled in winter by sleigh 45 miles to Sturgeon Landing, then by barge 130 miles down Saskatchewan River to The Pas, and thence 1,200 miles by rail to the smelter at Trail, B. C. As this was at a time before the days of the gasoline-driven tractor, it is cited that the ore hauled from the Mandy was not smelted at Trail until a year after it left the mine.

For a few years there was some activity in connection with the gold occurrences at Herb Lake. A small but noteworthy production came from the Rex (now Laguna) mine.

The operators were unable to finance its development properly and the mine closed down for some years. With the enhanced price of gold prevailing in 1935, exploration operations were renewed and Laguna Gold Mines Limited, a subsidiary of Mining Corporation of Canada, took over the property. The mine now known as Laguna has become since August, 1936, one of the most important gold producers in Manitoba.

Since 1915, there has been much of prospecting done in the vicinity of Flin Flon, Schist and Athapapuskow Lakes. Later the prospecting extended north to Cold (Kississing) Lake where a copper-zinc deposit was located in 1923 near Camp Lake by Phillip Sherlett, a Cree Indian, Carl Sherritt and Richard Madole. The claims later came to be known as the Sherritt-Madole group. After an option was taken on the group by J.P. Gordon, the name was changed to Sherritt-Gordon.



LAGUNA GOLD MINES LTD.

Many interests optioned the property between 1925 and 1927 when R. J. Jowsey of Toronto, Ontario, later associated with Thayer Lindsley, Boston, Mass., formed the Sherritt-Gordon Mines, Limited, to operate at the property, and the working of bringing the mine to production came under the management of Eldon L. Brown, who had been with the Victoria Syndicate, a subsidiary of the Mond Nickel Company, when it held an option on the property.

In the Summary Report, 1931, Part C, Geological Survey, Canada "Oxford House Area", J. F. Wright wrote as folllows:

> ".....Free gold had been reported from a number of localities in the area about God's Lake and, as the district appeared to offer opportunities, the country about God's Lake between Oxford and Island Lakes were explored geologically in 1931 ....."

Very little attention was paid to the God's Lake area by prospectors prior to 1932. A few parties had visited the area at different times and some attention was paid to it during 1928 and 1929.

In 1932, R. J. Jowsey with a prospecting party entered the area and soon made a discovery of gold on a small island north of the west tip of Elk Island. Other prospecting parties were quickly on the ground, and during the remainder of 1932 and early in 1933 many other discoveries were made mainly on Elk Island.

Many claims were staked during the period and early in 1933 several companies were organized to acquire claims in the area. The first company to undertake active development was God's Lake Gold Mines, Limited. Developments proved sufficient to warrant construction of a 150-ton mill. A power-plant of 1900-horsepower

capacity was completed at Kanuchuan Rapids, 40 miles southwest of Gods Lake settlement. Milling began within three years of the initial discovery of God's Lake. When it is considered that the property is 134 miles from the nearest railway facilities, and that even with winter freighting a considerable charge has to be added to costs, the operations at God's Lake may be considered among the most commendable carried out in Manitoba.

Milling capacity has since been increased to 200 tons a day and the company completed the year 1937 with an increase in its ore reserves.

The most recent addition to the rank of the producers in Manitoba is the Gurney Gold Mines, Limited. The first extensive development at the property near Copper Lake and 12 miles northeast of Cranberry Portage, was undertaken by the Wylie Dominion Gold, Limited, in October, 1933. Two years later the property was taken over by the Gurney Gold Mines, Limited, and more intensive development was done, in consequence of which the company was able to plan for a 125-ton mill which went into operation in October, 1937. The Dominion claims which form the nucleus of a group of nine, were originally held by A. L. Stewart and Robert Hassett who were active in prospecting in The Pas district.

Mines have come from that exploration considered adviseable by J. B. Tyrrell, as he wrote in 1917. Today his vision is realized in fact, for the mining industry of Manitoba, now firmly established, has brought into existence prosperous communities and, in doing so, has attracted an ever-widening public interest. Mining communities such as Flin Flon, Sherridon, Gurney, Herb Lake, God's Lake, Bissett and Beresford Lake, are well organized and a credit to the province.

Whether they are within easy reach of the railway or whether reached only by aeroplane, these communities have most of the amenities that are those of the city. Eight years ago the population in these frontier communities was small. Today the inhabitants are numbered in the thousands. As the prospector looks back on these communities, now providing good homes for many people, he may, in thinking of the solitude that once was all the frontiers possessed, look forward again and ask "Where will the next frontier be?"

TRANSPORTATION

The lack of facilities for cheap transportation was a serious hindrance to the employment of capital in the mines of Manitoba. This has, in a large measure, been improved in Pre-Cambrian areas by the use of the tractor during winter months for heavy machinery and bulk supplies, and by the use of the areoplane throughout the year for transportation of personnel and emergency requirements.

CHAPTER 3.

TRANSPORTATION

In spite of the rail and water facilities available in Manitoba, transportation into Manitoba's Pre-Cambrian areas has presented difficulties which had to be overcome by the operator undertaking the development of a mine at a considerable distance from the regular transportation facilities.

Mineral discoveries are not usually made on the travelled routes; rather do they appear to occur in the remoter and somewhat inaccessible places. Routes to such places are not normally direct or easy, while seasonal vagaries present problems in themselves. One mine may require a large programme of boat transportation in summer, followed by winter freighting. Another mine may be more economically reached by winter freighting, where large quantities of supplies have to be hauled during that season to carry the development and production work of the mine over a long period. This seasonal problem is then important and demanding, so that in out-of-the-way properties it is a major operation.

Twenty-one years--or since the first winter freighting was done to the Mandy property in 1917--have seen a m rked change in transportation methods in Manitoba, as elsewhere, for in that time the horse-drawn sleighs have given way to the tractor with its great loads and speedy travel. Particularly for the heavy machinery and great quantity of supplies that have to be transported in a short season, tractor haulage has removed many of those worries which, at one time, confronted the operator in the wilds. Now the bulk of the requirements for the long season when ground freighting is impossible can be taken care of in winter, and such lesser requirements as come during the summer season can be met by air transport. Today the frontiers

are served both winter and summer by aeroplane. And, while transportation to and from the industrial centres is thus maintained both summer and winter, that other form of communication, the radio, has come as a great boon to mining communities, as it has to all places remote from the normal centres of activity.

A review of the progress made in transportation methods into Manitoba's mining fields is not without interest, as it includes the winter hauling of large quantities of machinery and supplies, in the first instance by horses and later by tractor. To the Mandy mine on Schist Lake the first considerable volume of freight was moved in 1917. Turning to the accounts of that early mining activity in Manitoba one reads:

> "In December, 1916, the Mandy Mining Company let a contract for hauling of at least 3,000 tons of ore to the head of navigation, some 40 miles distant. During the summer of 1917, 3,300 tons were conveyed by barge to The Pas and then shipped to Trail, B. C. The total transportation distance is approximately 40 miles by wagon, 130 miles by water and 1,200 miles by rail. This was, therefore, an unique undertaking in mining transportation......... In 1918, 6,000 tons of ore were shipped and in 1919, 15,000 tons of ore were ready for transportation and 200 teams were at work on a 40-mile stretch between the mine and the head of navigation. The average load of a single team of horses for the winter haul was 6½ tons and the cost of transportation 3½ cents a ton-mile. At the peak 300 teams were employed."

Freighting of machinery and supplies to the Flin Flon property was done from the winter of 1916 on. In summer the route from The Pas to Sturgeon Landing and thence across to Lake Athapapuskow was used, and in winter the road followed the Saskatchewan River for a short distance above The Pas and then, leaving the river, by Reeder, Rocky and Sturgeon Lakes to Sturgeon Landing, and from there over the same route as the summer one, only across the frozen lakes.

In the winter of 1926-7, the building of a power plant and a pilot mill at Flin Flon required much heavier freighting then heretofore. Following the decision of the Whitney and Newmont interest of New York and Mining Corporation of Canada to go ahead with the bringing of the Flin Flon mine into production, Hudson Bay Mining and Smelting Company, Limited, was incorporated and arrangements were completed for the building of 87 miles of railway from the Hudson Bay line. Early in 1928 construction was under way.

The development of the Sherritt-Gordon mine was the next to follow Flin Flon, and on January 10th, 1928, the work of hauling plant and supplies to the property was started. A winter road, 80 miles in length, had to be prepared from mileage 55 on the Hudson Bay railway. By March 16th, 2,380 tons were hauled, 150 teams of horses, three Holt and one Lynn tractor being used in the work. The supplies hauled were intended to look after 140 men until the end of 1928.

With the completion of the railway to Flin Flon, Hudson Bay Mining and Smelting Company, Limited, prepared immediately for the movement of some 25,000 tons of material and equipment from Mile 86 over 69 miles of winter roads to Island Falls on Churchill River, where hydro-electric power for the Flin Flon plant was to be developed. In the work 12 Lynn tractors and other lighter trucks were used. The freighting was done on 150 special 60-inch gauge sleighs. Small camps were erected at various places along the road. Tractors and loads were despatched practically on schedule and kept track of en route. Roads were kept ploughed after every snow-storm over the route which comprised 44 miles over lakes and 25 miles over portages. Between December 15th and March 15th, all the freight was moved. In some instances loads up to 120 tons were hauled by one tractor.

The railway was also to serve the Sherritt-Gordon mine, permitting of a shorter haul from Cranberry Portage than that of the previous winter. While awaiting the construction of a railway from Cranberry Portage to the Sherritt-Gordon mine, a winter road, 54 miles in length, was made, using portages and lakes. A total of 3,600 tons of freight was hauled in a period of about 90 days, at a cost of 27 cents per ton-mile. The hauling was all done by Lynn tractors, using trains of sleighs for each tractor.

In the winter of 1929-1930, another 12,000 tons of freight were hauled from Mile 86 to Island Falls. With all equipment on the ground, the power plant was made ready to supply power to Flin Flon by July, 1930.

The use of the tractor as a means of transport over comparatively long distances was definitely settled in these winters of 1929 and 1930. Distance no longer had any terrors for the mine operator, and, with another chapter written into the history of mining in Manitoba, the tractor, a few years later, made possible the development of a mine such as God's Lake, 132 miles distance from railway facilities. With experience, another 125 miles is now added to this as mines are being opened up in Ontario directly to the east of God's Lake.

During the first three months of 1935, 4,713 tons of machinery, building material and supplies were hauled over the winter road from Ilford to the God's Lake mine. Of this, 1,600 tons went to the Kanuchuan Power Development. The haul amounted to 668,600 ton-miles and was made at an overall cost of 22.85 cents per ton-mile, exclusive of depreciation.

The 1936-1937 winter-freight hauling activities were carried through with much success. Due to the variable nature of the ice conditions on the several lakes, the season was short, but nevertheless, the stipulated tonnage was safely transported. From Ilford, Mile 286 on Hudson Bay railway, the freight depot, there was hauled to God's Lake by tractor a total tonnage of 2,365. In addition to this a considerable tonnage was hauled into the Sachigo River area in Ontario via God's Lake.

Transportation into the Rice Lake area has been taken care of both winter and summer. The San Antonio mine in winter is served by road 40 miles from Pine Falls, while the Central Manitoba section, including the Gunner and Oro Grande mines, has been served by winter road 55 miles. In summer San Antonio is served from Winnipeg by Lake Winnipeg, Hole River and road, while the Central Manitoba section is served by the same route via Cariboo Landing and water route to Long Lake and thence by road.

During the summer of 1932, camps were built for the Island Lake mine. Mine and mill equipment, together with supplies, was assembled at Selkirk and shipped to Norway House at the north end of Lake Winnipeg. Early in 1933 this material was transported 174 miles over winter road to the mine at Island Lake. The last of the material reached its destination March 29th. Much difficulty was experienced in freighting operations due to heavy snowfalls before the lakes and muskegs were sufficiently frozen. The first trip with tractor took one month to complete. During the hauling, two jaw-crushers and one 60 h.p. tractor were lost through the ice. The two crushers were later recovered.

The following will give some idea of the distances that have had to be travelled in freighting for mining areas in Manitoba:

Northern Manitoba

The Pas to Sturgeon Landing	125 miles
Sturgeon Landing to Lake Athapapuskow (Camp 2)	16 miles
Lake Athapapuskow to Mandy Mine	28 miles
Lake Athapapuskow to dock at Ross creek	32 miles
Flin Flon to dock at Ross creek	2 miles
The Pas to Flin Flon	92 miles
Flin Flon (mile 86) to Island Falls	69 miles
Mile 82 (H.B.Ry.) to Hale's Landing (Herb Lake)	12 miles
Hale's Landing to Herb Lake settlement	10 miles
Mile 55 (H.B.Ry.) to Sherritt Gordon mine	80 miles
Cranberry Portage to Sherritt Gordon mine	54 miles
Cranberry Portage to Elbow Lake	30 miles
Cranberry Portage to Century mine (Webb-Garbutt)	36 miles
Mile 12 (Optic Lake Siding, Man.Nor.Ry.) to Gurney mine	4 miles
Mile 21 (Heming Siding, Man.Nor.Ry,) to Century mine (Webb-Garbutt)	11 miles
Mile 286 (Ilford, H.B.Ry.) to God's Lake mine	132 miles
Mile 286 (Ilford, H.B.Ry.) to Knee Lake	82 miles

Eastern and Southeastern Manitoba

Winnipeg to English Brook	125 miles
English Brook portage at Hole river	2 miles
Winnipeg to Manigotagan (Bad Throat) river	120 miles
Manigotagan river to landing above English Brook portage	7 miles
Hole river to Government Landing	20 miles
Government Landing to San Antonio mine	9 miles
Government Landing to Cariboo Landing	17 miles
Cariboo Landing to Long Lake	14 miles
Long Lake to Central Manitoba mine	5 miles
Long Lake to Gunnar mine	6 miles
Central Manitoba mine to Gunnar mine	7 miles
Great Falls to Central Manitoba mine or Gunnar mine	55 miles
Great Falls to Gem Lake (Diana) mine	51 miles
Central Manitoba mine to San Antonio mine	18 miles
Pine Falls to San Antonio mine	42 miles
Winnipeg to West Hawk and Falcon lakes	110 miles
Winnipeg to Norway House	312 miles
Norway House to Island Lake mine	174 miles
Norway House to Echimamish river	55 miles
Winnipeg to Lac du Bonnet	70 miles
Lac du Bonnet to Bird River area	32 miles

GEOLOGICAL WORK IN MANITOBA

Sir William Logan, the first director of the Geological Survey of Canada, inaugurated the study of Pre-Cambrian formations.

CHAPTER 4.

GEOLOGICAL WORK IN MANITOBA

It is only within the past century that geological science has advanced to a stage where the mineral endowments of an area could be appraised with any degree of accuracy. Formerly, the geologist's interpretation of earth history was extremely conjectural. Rock forms were in many cases accurately described by early investigators but the important history leading to their ultimate development was missed completely and criteria leading to the discovery of ore-bodies were almost entirely lacking.

The beginning of the unravelling of the complex geology of the Pre-Cambrian Shield of northern Canada was started by Sir William Logan, the first director of the Geological Survey of Canada. He did his pioneer work well, and, as he inaugurated the study of Pre-Cambrian formations, he has been rightfully named the Fathdr of Pre-Cambrian Geology. He began his connections with the Geological Survey of Canada in 1843.

Since the time of Logan, geological surveys ~~have~~ been made over most of the Dominion of Canada and among the earliest investigators in this province were Dowling, Tyrrell and McInnes. Their maps were, however, largely compiled from observations made along shore-lines and geological boundaries were projected inland along the prevailing strike or direction of the rock formation.

Observations were made from time to time on the topography and geological formations of Manitoba by the early explorers, La Verendrye (1734-1739), Pond (1778-1790), Thompson (1793-1805), Henry (1799-1808), Fidler (1794-1809), Harmon (1800-1819), Keating (1823), Franklin (1819-1827), Richardson (1819-1851), Palliser (1857),

S. J. Dawson (1858), and Hind (1857-1858). From 1873, more than half a century ago, with the work of G. M. Dawson, Bell and Spencer, and later Tyrrell, Dowling and Uphom, there was initiated that systematic investigation by the Geological Survey of Canada, which has continued, under the later auspices of the Geological Survey and Mines Branches of the Department of Mines and Resources to the present time. While very important observations were made by the early explorers they were necessarily isolated. Continuous work in the interpretation of the geology of the province may therefore be considered to be confined to the last fifty years, or somewhat more.

Geological surveys vary in their objectives to a great degree and consequently vary widely in the method of procedure followed in making the survey. The first work done by the Geological Survey of Canada in Manitoba, was of a reconnaissance nature. Wide areas were covered by the most advantageous routes and the economic possibilities or suggested possibilities were noted and recorded in early reports. Following the reconnaissance survey were investigations of a more detailed type, the extent of which depended upon the encouragement received as the work progressed.

Thus, the geological maps issued, covering the geology of Manitoba, are seen to vary in detail depending on the size of the area covered by the map. Broad subdivisions of rock types are used when generalizations are required. Maps employing a scale of a mile or more to an inch are more general, grouping several rock types under one distinguishing color or pattern on the map. Maps of this sort accompany reports issued dealing with the area and in the report are detailed descriptions of each rock type, grouped collectively under one division. Embodied in the report are conclusions dealing with the broader economic aspects of the areaand specific recommendations are

usually made concerning certain rock relationships which will enable the prospector to direct his attention to definite localities or rock types.

In areas where the presence of ore-bodies has been definitely established, further detailed mapping is frequently undertaken to assist operators in the area, whether producing or developing, in a more scientific approach to their ore problems. Detailed studies such as this are frequently made to correlate and substantiate evidence obtained by an examination of surface exposures. Seeing the third dimension exposed in mine workings is of great assistance to the thorough understanding of rock relationships.

It must be acknowledged at this point that operating mines make a practice of giving very freely of the information gained through very costly development programmes. It is felt that only by an unrestricted interchange of information and thought in any area can the complex history of the Pre-Cambrian become unravelled.

Maps prepared to accompany reports on restricted areas are much more precise in the naming and location of outcrops and contacts than are the large areal map and are usually so accurate that diamond-drill and development programmes can be guided by them.

Influence of Discoveries in Pre-Cambrian of Northern Ontario on Manitoba

Progress in any field of endeavour is, or should be, guided by the experience of others, whether that experience takes the form of good fortune or costly error. For years the occurrence of a wide range of metals had been noted in the Pre-Cambrian of Northern Ontario. Various deposits were visited by mining engineers of international

repute and an opinion was expressed based upon the soundest scientific considerations of that time that the ore-bodies, while certainly attractive at the surface, would not continue to depths that would justify the outlay of much capital in the development of the deposits.

Time has proven their contentions to be incorrect. Some deposits, it is true, petered out. However, in many instances these original veins were found to be paralleled at depth by other ore-bodies that did not come through to the surface. And so the mines went down and are still going down.

What, then, is the inference to be drawn concerning the Pre-cambrian mineral areas of Manitoba? Surely we in Manitoba are justified in expecting a similar measure of success in the developing of our Pre-Cambrian ore deposits. Prospectors acquainted with the type of rock formation considered favourable in other Pre-Cambrian areas have come into Manitoba and have located mines. Our history is very immature in metal mining and some early set-backs have been received, but where development has been carried to depth in the great majority of cases success has crowned the efforts of the prospector and the mine operator.

It should be stated that, in so far as available geological data are concerned, there is positively no reason to believe that areas possessing similar rock assemblages to those found to be productive in Ontario or Quebec will not prove in time to be equally productive in Manitoba. The history of mining development in Northern Ontario has given us every assurance that we may expect to no small degree similar rewards to those being reaped by mines operating elsewhere in the Canadian Shield.

AREAS FAVOURABLE FOR PROSPECTING AND WHAT MAKES THEM SO.

A reference to the outline of the geology of the Province will show why large greenstone masses surrounded by large areas of granite and allied rocks are regarded as favourable for prospecting. It is believed, with good reason, that ore minerals originating within the main body of the granite are emplaced within the intruded greenstone during the period when magmatic vapours are emanating from the cooling granite mass. The "greenstone" bodies appear to act as a sponge or receptacle for ore solutions originating from the granite.

Not all parts of a greenstone area are equally favourable for the deposition of ore deposits. Nor would it appear that all greenstone areas are equally favourable. The parent magma or granite intruding the greenstone would seem to be a controlling factor in the latter instance. In the former case major rock features such as folds, competent and incompetent members of a rock series, have the ability to resist deformation. Such forms lend themselves readily to replacement by ore solutions or conversely rock forms which are impervious to ore solutions and thus act as an impenetrable barrier damming the solutions to form ore deposits against the impervious barrier, all contribute their share to the localization and emplacement of ore-bodies.

In addition, the underlying configuration of the roof of the intruding granite mass and the older greenstone body plays an important part in localizing ore deposits as well as does the length of time the granite or related rock type took to cool and thus permit a free passage of volatile constituents into the older intruded rock forms. The above conditions having been satisfied entirely

or in part, erosion must not have progressed too deeply and removed all but remnants of original ore deposits. In any case secondary or surface enrichment is not expected to play an important part in ore deposition.

When it is realized that the above conditions are necessary to the formation of many of our ore-bodies, it will be realized why prospecting is such a painstaking and tedious task. Every outcrop must be examined for clues which might lead to the discovery of a rusted area. The rusty zone must then be blasted into to ascertain the nature of the mineralized material in the fresh rock below and the ore zone traced along its surface exposure or, in flat areas, its "strike", to determine its linear extent. It has been humourously but truthfully said that "the geologist finds the haystack but the prospector must locate the needle". Reduced to common expression, it is the work of the geological survey to delimit the areas favourable for prospecting, but it is the task of the prospector to examine those areas in close detail in an endeavour to make a discovery.

PHYSIOGRAPHY AND GEOLOGY

The area of the province of Manitoba is 251,832 square miles.

More than three-fifths of this area is underlain by rocks of Pre-Cambrian age.

In this area there are mineral deposits of economic importance. Mines are being operated; others await discovery.

CHAPTER 5.

THE GEOLOGY OF MANITOBA

PHYSIOGRAPHIC FEATURES

Manitoba is a region of low relief. Elevations vary from sea level on Hudson's Bay to a maximum of less than 2,600 feet on the escarpment in the southwestern part of the province. Only a small fraction of the total area shows elevations greater than 1,500 feet. Notwithstanding the relatively small differences of elevation, several physiographic units are discernible. These units are definitely related to the underlying bedrock, so that a separate physiographic map is not required to supplement the accompanying geological sketch-map (Figure 1). A glance at this map serves to emphasize the following physiographic units: (1) A great central area underlain by Pre-Cambrian rocks, of low relief but rough surface, with innumerable lakes occupying glacially eroded rock-basins: (2) an area west of a line bisecting Lake Winnipeg which is underlain by Ordovician, Silurian and Devonian limestones. (This belt includes the level plains of the basin of the Red and lower Assiniboine rivers, which have a covering of glacial lake beds); (3) The Hudson's Bay slope underlain by Ordovician and Silurian limestones (both limestone areas are monotonously flat, though the former has some notably large and shallow lake basins); and (4) the comparatively deeply dissected and elevated escarpment of southwestern Manitoba, underlain by rocks designated Cretaceous on the map.

The details of topographic form were largely determined by glacial erosion in comparatively recent times and by minor post -

Glacial erosion. Similarly, most of the soil and mantle rock which cover much of the bedrock of the province is composed of glacial drift and minor amounts of modified drift materials.

The drainage system of Manitoba has been influenced in large measure by its inheritance of glacial topography. In the greater part of the province the drainage systems follow depressions formed by the ice-sheets. Falls and rapids are numerous and the typical system is a chain of lakes joined by short streams. The drainage from the entire province enters Hudson's Bay. Though the region has no great elevations, there is a wealth of water-power available. An important reason for this is that several trunk rivers traverse Manitoba. These rivers, notably Winnipeg, the Red and Saskatchewan, drain large regions outside the provincial boundaries.

A direct relation is apparent between the productive soils and the physiographic units of the province. The best agricultural lands were provided by the lake-beds which overlie the southern part of the regions.

GEOLOGY

INTRODUCTION

Unconsolidated surface deposits are in more or less evidence in all Manitoba areas. In the south and southwest especially, and also in a considerable area on the Hudson's Bay slope, to say nothing of numerous smaller areas, glacial drift and glacial lake beds of Pleistocene age conceal the underlying consolidated bedrock. Elsewhere rock exposures may be numerous but are not continuous for great distances owing to the numerous lakes, swamps, and more or less continuous sheet of glacial deposits. Where the bedrock surface is uneven, the higher knolls and ridges are commonly bare or hidden by scant vegetation and glacial drift, while the intervening low ground is occupied more or less deeply by boulder clay and swamp deposits.

The older and more consolidated formations lying beneath and conveniently called collectively the bedrock, are for descriptive purposes best referred to three major groups. The oldest of these are Pre-Cambrian rocks. Reference to the geological sketch-map, Figure 1, shows that these form the bedrock in about three-fifths of the province. Moreover, as shown in the geological section, Figure 2, they underlie later bedrock formations in the remaining two-fifths. A line projected through the major axis of Lake Winnipeg from the southeast corner of Manitoba and thence westerly to the middle of the western boundary of the province, is roughly the southwestern limit of outcrop of Pre-Cambrian formations. They are hidden again by later formations in a large area adjoining Hudson's Bay. Flat-lying limestones of Palaeozoic age, the second

VERTICAL CROSS SECTION ACROSS SOUTHERN MANITOBA

SHOWING

GEOLOGICAL COMPOSITION

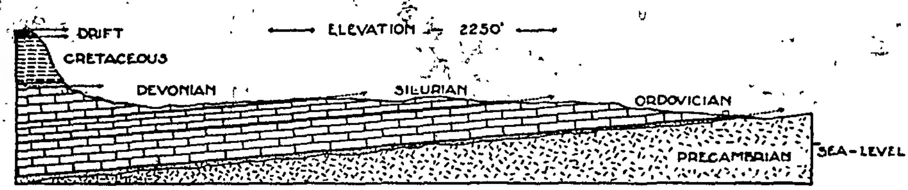


Fig. 1

major group of rock formations found in the province, form the bedrock in the Hudson's Bay area as well as in the southwest where they occupy a wide belt extending from some distance north of the Saskatchewan river to the United States boundary and beyond. Lakes Manitoba and Winnipegosis, and the western side of Lake Winnipeg, lie in this belt. Limestone outcrops are not numerous or large. They appear above the drift in a few eminences and along lake shores and a few marginal escarpments. The third main group of bedrock formations, which includes sandstones, shales and only minor amounts of thin bedded limestone, overlies the Palaeozoic limestones in southwestern Manitoba. The truncated edges of these later formations form the broken escarpment of this region. The rocks appearing in the escarpment are of Cretaceous age and are largely marine in origin. A small area of continental sediments containing thin beds of lignitic coal appears in the neighborhood of Turtle Mountain, close to the North Dakota boundary. These rocks are either transitional beds between Cretaceous and later times or are of early Tertiary age. The rocks of the escarpment are in general relatively unconsolidated and too friable to serve directly as building materials.

A general scheme of classification of the geological formations of Manitoba, suggested in the foregoing brief description, and useful as a basis for subsequent discussion, is indicated in tabulor form as follows:-

Cenozoic	Quaternary (Glacial and recent deposits)
	Tertiary
Mesozoic	Cretaceous (upper)

Palaeozoic	Devonian Silurian Ordovician
Pre-Cambrian	Igneous and metamorphic rocks

PRE-CAMBRIAN

The oldest rock formations containing enough well preserved fossil remains to permit a world-wide correlation are known as Cambrian. For want of a better term, rocks older than Cambrian are conveniently referred to collectively as Pre-Cambrian. World-wide correlation of these, the most ancient rocks, is impossible owing to the almost entire absence of fossil remains. Even across the more or less continuous area of the Canadian shield, correlation between widely separated areas is never on a sure basis. In recent years much progress has been made in assigning ages to ancient rock formations by determining the amount of radioactive disintegration and it becomes more and more possible, therefore, that widespread correlation of Pre-Cambrian formations may yet be permitted. Such age determinations indicate that about three-fourths of Manitoba's geologic record is written in its Pre-Cambrian formations.

In each of the Pre-Cambrian areas of the province the geologist can usually establish a certain sequence of formations which indicates a certain succession of geological events, but it is impossible to correlate events in widely separated areas. For this reason it is inadvisable to attempt the making of a time classification which will apply to the formations of the entire province. However, the various parts of the Pre-Cambrian region have many features in common and these will be briefly indicated:-

Distribution and Surface Features - About three-fifths of Manitoba's area has Pre-Cambrian formations as bedrock (Figure 1). The same rocks underlie the remainder of the province (Figure 2) but are covered in the remaining two-fifths by later formations.

The entire Pre-Cambrian shield area shows the characteristic surface features of ice-sheet erosion and deposition. The bedrock surface is hummocky. Rounded hills and ridges of rock alternate with basin-like depressions and valleys where the bedrock surface is concealed beneath lakes, swamps, or a variable thickness of glacial drift. The proportion between covered and uncovered bedrock is extremely variable from place to place and depends on several factors, notably the differences in relief on its surface in relation to the amount of material deposited by the ice. Much bedrock is concealed beneath lakes which occupy glacially excavated rock-basins, notably in regions where the general surface grade is gentle.

Geology.- Granite and allied rocks with their gneissic equivalents make up the great bulk of Pre-Cambrian rocks. These rocks are known to have formed from the molten state at great depths below the surface. The existence of abundant rocks at the surface which were formed at great depths, implies that thicknesses of thousands of feet or miles of rock material have been eroded or removed from Manitoba's Pre-Cambrian areas. Here and there across the shield the outcrops of granites and gneisses are interrupted by bedrock exposures of the so-called schists. The latter are metamorphic equivalents, in general, of surface-laid sedimentary rocks and lavas which had become involved with mountain -folding movements and intrusions of granitic magmas. The belts of schist are mere remnants of formerly widespread and abundant formations. It is generally assumed that if erosion from

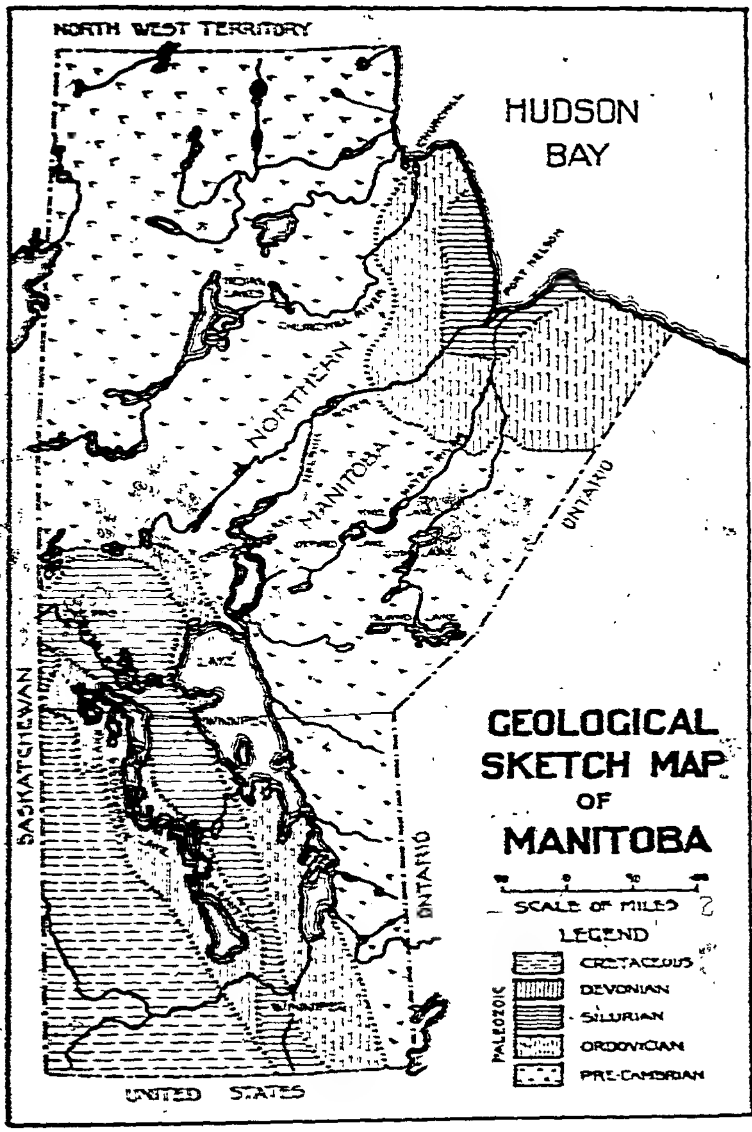

NORTH WEST TERRITORY
HUDSON BAY
NORTHERN MANITOBA
SASKATCHEWAN
ONTARIO
UNITED STATES
GEOLOGICAL SKETCH MAP OF MANITOBA
LEGEND
CRETACEOUS
DEVONIAN
SILURIAN
ORDOVICIAN
PRE-CAMBRIAN
PALEOZOIC

Fig. 2

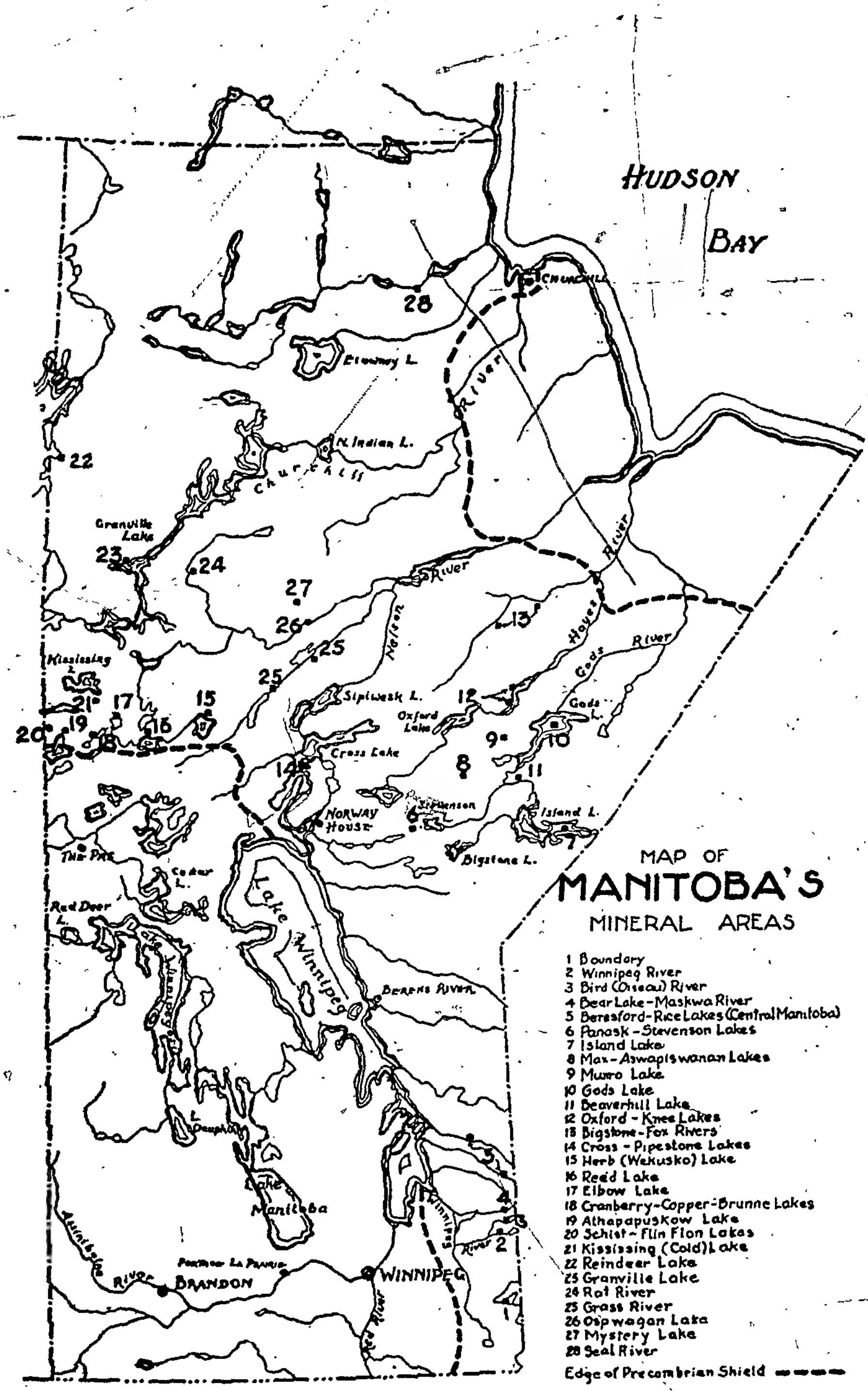
the shield had been less deep, the belts of schist would be correspondingly larger, and similarly, that further erosion would tend to obliterate all signs of schist. In some areas of the province erosion seems to have removed all traces of the schistose rocks, while in others these rocks are very prominent and may even dominate in areal extent over the granitic rocks.

The areas occupied by schistose rocks are in each instance surrounded by granitic rocks and are of variable form and size. Most commonly the schist occupies an area which is elongated in outline and appears on the map as a long and relatively narrow band or perhaps in the form of an ellipse. Irregular patterns and roughly equidimensional areas are known. In size the schist occurrences range from small inclusions to larger areas several miles across and tens or scores of miles in length. Typically the schistose structure is parallel to the boundaries of the area. Dips vary from nearly horizontal to vertical and are commonly fairly steep. It is frequently inferred that the steeper the dip and the wider the band of schist, the deeper it will extend into the surrounding granite, though little is positively known concerning the changes in size and attitude of the bodies of schist in greater depths.

General features and relations between prevalent types of rock in Manitoba's Pre-Cambrian area have been indicated. While there are many features common to all areas, each has its own detailed characters. Most of the published information concerning the many different areas of the province is found in the reports and maps of the Geological Survey of Canada. Much of the Pre-Cambrian area has not been geologically mapped. Reconnaissance surveys have been made of large portions but the rocks of relatively few small areas

have been studied and mapped with considerable detail. During the past twenty-five years the investigations of the Geological Survey have been directed toward those areas of the province which gave promise of containing metalliferous deposits of value. It happens that throughout the Pre-cambrian Shield the regions containing prominent areas of schist have proved to be those of greatest economic importance, so that in Manitoba attention was largely directed to the mapping of prominent belts of schist. Consequently, an examination of the published maps of the different parts of the province's Pre-Cambrian might convey the impression that schist is more prevalent than it is in the region as a whole. The accompanying sketch-map of the province (Figure 3) showing the metalliferous areas indicates as well the important areas of schistose rocks, for it is in these formations that practically all metalliferous deposits have been located. Geological Survey reports and maps available at the present time are concerned chiefly with these same areas. It is obviously impossible to offer in this summary the geological details of the many economic areas of the province. Instead, a selected bibliography is attached.

Economic Geology.- Not only in Manitoba, but throughout the Pre-Cambrian Shield, metalliferous deposits are almost invariably in intruded rocks (schists, etc.) and not in the intrusive granitic rocks. A few exceptions might be noted where ores are in associated intrusives, but these are usually basic rocks and not of the prevailing granitic types. Statistical evidence favours the view, therefore, that the most promising areas of the province for metalliferous deposits are those where the larger remnants of intruded rocks, notably schists, have escaped erosion. Wide regions, where intrusive rocks of the



HUDSON BAY
MAP OF MANITOBA'S MINERAL AREAS
1 Boundary
2 Winnipeg River
3 Bird (Oiseau) River
4 Bear Lake-Maskwa River
5 Beresford-Rice Lakes (Central Manitoba)
6 Panask-Stevenson Lakes
7 Island Lake
8 Max-Aswapiswanan Lakes
9 Munro Lake
10 Gods Lake
11 Beaverhill Lake
12 Oxford - Knee Lakes
13 Bigstone-Fox Rivers
14 Cross - Pipestone Lakes
15 Herb (Wekusko) Lake
16 Reed Lake
17 Elbow Lake
18 Cranberry-Copper-Brunne Lakes
19 Athapapuskow Lake
20 Schist - Flin Flon Lakes
21 Kississing (Cold) Lake
22 Reindeer Lake
23 Granville Lake
24 Rat River
25 Grass River
26 Ospwagan Lake
27 Mystery Lake
28 Seal River
Edge of Precambrian Shield
Churchill
Churchill River
Nelson River
Hayes River
Gods River
Etawney L.
N. Indian L.
Granville Lake
Kississing L.
Sipiwesk L.
Oxford Lake
Cross Lake
Norway House
Stevenson L.
Island L.
Gods L.
Bigstone L.
The Pas
Cedar L.
Red Deer L.
Lake Winnipegosis
Lake Winnipeg
Berens River
L. Dauphin
Lake Manitoba
Portage La Prairie
Brandon
Winnipeg
Assiniboine River
Red River
Winnipeg River

Fig. 3

granitic type occur to the complete or almost complete exclusion of intruded rocks, offer little promise for metal production. No comprehensive map of Manitoba exists which would show the regional distribution of schists and granites in the Pre-Cambrian Shield area. However, because of the close association of metalliferous prospects with important areas of schist, the accompanying sketch-map (Figure 3), showing in a general way the areas where discoveries have been made, serves to indicate the regions where outcrops of schist are notably exposed. The most promising metalliferous areas have been mapped by the Geological Survey of Canada and maps in greater or less detail are to be found in the publications listed or implied in the attached bibliography.

Viewed in a world-wide way, ore deposits occur in several genetic groups, each of which contains a variety of types characterized by diverse assemblages of ore minerals. A genetic group reflects, in its minerals, past geologic processes and environments, so that the groups represented in Manitoba's Pre-Cambrian areas are those determined by the geological history of the provincial region. It happens that not all genetic groups of ores are found in the region. To permit reasonable anticipation of future metal production, and to guide further prospecting and development, it is important to find out what genetic groups of ores are permitted by geological events of the past, and, at the same time, to show the kinds of mineral deposits not likely to occur. The procedure followed in attempting to do this will be to list the commonly accepted genetic groups and their included types of ore and to indicate what bearing the geological history of the province has on the occurrence of each group or type:-

Group 1. Sedimentary Deposits. Include concentrations of metals or valuable metalliferous minerals formed contemporaneously with the sedimentary rocks which contain them.

Type a) - Placer deposits, notably of gold, platinum and tin.

Of this type it may be safely said that any placers formed by subsequent erosion in Pre-Cambrian areas have been dissipated by ice-erosion in Pleistocene time. Seemingly the only possibility for the occurrence of this type is in areas where Palaeozoic limestones cover Pre-Cambrian formations and served to protect any existing placers from glacial erosion. There remains the further possibility that ancient placers were buried beneath later Pre-Cambrian formations and might be found in the metamorphosed sediments observed in many belts of schist. Such "fossil" placers have not yet been found in the province or elsewhere in the shield rocks. There is little promise that either of the possible kinds of ancient placer will contribute importantly to the province's mineral production.

Type b) - Sedimentary iron-ore.

This type supplies the bulk of the world's iron and the most important deposits are in Pre-Cambrian formations of Minnesota, Wisconsin and Michigan, not far distant from Manitoba. It might be wondered why this important type of ore, so abundantly represented in the States adjacent to Canada, is not so conspicuous in the neighboring Canadian Pre-Cambrian. Again, ice-sheet erosion has been a determining factor. Sedimentary iron-formation is known to occur in important quantities in Ontario's schist belts and in a smaller way in Manitoba. However, the original iron-formation is low grade and serves only as protore for later enrichment by weathering and underground waters. In the States to the south such enriched iron-formation has escaped the ravages of ice-erosion,

while in Manitoba only the low-grade protore remains. This province is not looked on, therefore, as a promising source of Pre-Cambrian sedimentary iron ore. The same argument rules out the possibility of important manganese deposits of related type.

Group II. Deposits formed from circulating underground waters, typically deposited in sedimentary rocks at relatively shallow depths by comparatively cool waters.

In several parts of the world deposits of lead and zinc ores and perhaps others of copper and iron are supposed to have been formed in this manner. The Pre-Cambrian region of Manitoba has been so deeply eroded in subsequent times that the finding of this kind or ore in rocks of that age is definitely excluded.

Group 111. Shallow veins from rising hot waters. Included in this group are the so-called bonanza ores of gold and silver, also mercury ores and certain deposits with arsenic and antimony.

Again, the great erosion suffered by Pre-Cambrian areas rules out deposits of this kind in the province. There is only a remote possibility that remnants of these bodies have been buried and preserved as "fossil" ore-bodies, but the discovery of workable deposits is very unlikely.

Group IV. Veins and other deposits formed at intermediate depths by ascending hot waters.

This of all the groups listed embraces the greatest variety of ores and included metals. By far the largest fraction of the world's workable deposits belongs here. Of the many types are 1) copper ores with gold and silver or both metals, 2) lead-zinc ores with silver, 3) lead-antimony ores, 4) silver ores, 5) gold ores, 6) tungsten ores, etc. etc.

No workable deposit so far found in Manitoba belongs definitely to this group, though there are possibilities for some of the types in the province. There is a gradual transition between this and Group V, and some local deposits may be transitional or correspond to the deeper varieties of Group IV.

Depth of erosion seems still to be the determining influence in excluding most types of this group from the province. Transitional types of copper-zinc ore with silver and gold, gold-quartz veins and perhaps tungsten-quartz veins are among the possibilities.

Group V. Deep veins formed at high temperatures. Viewed in a world-wide way this group includes important 1) gold-quartz veins, 2) copper-zinc veins with values in gold and silver, 3) copper veins with gold, 4) copper-tin veins, 5) tin veins, 6) magnetite (iron) veins, etc.

This is the first of the listed groups of great importance in Manitoba's Pre-Cambrian. The province's chief metal production so far comes from gold, copper and zinc. The deposits which have yielded this production are high temperature gold-quartz veins and high temperature copper-zinc deposits. It is difficult to make sharp distinction between the deeper members of Group IV and these but it is safe to say that most of Manitoba's producing mines and most promising prospects belong to this Group or are closely related and belong to Group IV.

The importance of this group as a source of gold, copper and zinc has been proved. Other possibilities lie in tin and iron, while those for lead, silver, antimony, tungsten are much more remote.

Group VI. Contact Metamorphic Deposits. Important world deposits of copper, gold, tin, iron and tungsten belong to this group.

In Manitoba no workable deposit or promising prospect belongs definitely to the group of contact metamorphics, but geological environment permits their occurrence. Perhaps important representatives of the group, however, have been lost in the deep erosion. Copper, iron and tungsten, and perhaps tin might yet be found in deposits of this kind. The absence of such replaceable rocks as limestones in the Pre-Cambrian formations of the province is not encouraging.

Group VII. Magmatic Segregations. Includes deposits of nickel and copper sulphides commonly containing members of the platinum group of metals and almost invariably associated with gabbro and norite rocks. Other important possibilities in the group are iron ores, notably magnetite and titaniferous magnetite.

Gabbros and probably norites occur in Manitoba and in one occurrence, north of Oiseau River, numerous prospects containing nickel and copper sulphides have been found and developed. These ores are similar in many ways to the famous Sudbury nickel-copper deposits. There are possibilities for further discoveries of this type of ore, as well as for finding segregations of iron ore.

Group VIII. Pegmatites. These are common dyke rocks in regions of granite intrusion. A small percentage of them show notable concentrations of rare elements, some of which do not occur in any other type of deposit.

Manitoba's Pre-Cambrian areas are occupied dominantly by granitic rocks and pegmatites occur in profusion. Those dykes containing concentrations of rare elements have been located in many parts of the province, notably near Falcon Lake, between Winnipeg

and Oiseau Rivers, and on Wekusko (Herb) Lake. Prominent concentrations of lithium and beryllium minerals are of special significance in some dykes. Tin, tantalum and phosphate minerals have also been concentrated in some bodies. Potash feldspar has been produced from Winnipeg River pegmatites in a small way.

While it is true that pegmatites have not contributed in a large way to the world's metalliferous production, more may be expected from this group in future years. If this proves to be true, much may be expected from the pegmatites of the province.

Group IX. Secondary Enrichment Deposits. These form a very important group in some parts of the world. They result from weathering, or processes of rock decay, in which certain materials, notably copper, are carried downward in solution and deposited at lower levels in more concentrated form, or, in other instances, soluble material is removed to leave a concentrated residue of value.

Unfortunately, this type of deposit is almost excluded from Manitoba's possibilities, owing to recent geological events. The great ice-sheets of Pleistocene time removed practically all weathered products from the provincial area. The Pre-Cambrian surface shows only fresh and comparatively unaltered rocks and ore-deposits. The only possibility for deposits of this group seems to lie on the Pre-Cambrian surface beneath the cover of Palaeozoic limestone, which served to protect the ancient weathered surface from ice-erosion. In fact, a narrow strip of Pre-Cambrian, marginal to the covering limestone, does show more or less weathering, and maturely weathered clay materials have been found in this strip in the basin of Lake Winnipeg. Unfortunately, most of this weathered strip is inaccessible,

and it is next to impossible to prospect the larger area of possibilities where the limestone covering is thick. Post-Glacial weathering has been insignificant, and in no instance has it gone far enough to be a factor in the production of secondary ore, or more than a very small factor in the enrichment of primary ore.

PALAEOZOIC FORMATIONS

Only three of the several recognized periods of the Palaeozoic era are represented by formations in Manitoba. The formations included in the three periods, as viewed in southwestern Manitoba, are listed in the following table, the oldest formation being placed at the bottom and the youngest at the top:

Devonian:	Manitoban Limestone	185 feet
	Winnipegosan Dolomite	168 "
	Elm Point Limestone	25 "
Silurian:	*Leperditia hisingeri* zone	100 "
	Gypsum beds	150 "
	Conchidium decussatum zone	135 "
Ordovician:	Stony Mountain Shales	190 "
	Upper Mottled Limestone	130 "
	Cat Head Limestone	70 "
	Lower Mottled Limestone	70 "
	Winnipeg Sandstone	100 "

The thickness of the various formations listed in the Table are maximum thickness. The maximum total thickness is probably less than 1,000 feet in most of the Palaeozoic area. Only the Ordovician and Silurian periods are represented in the area of Palaeozoic formations found on the Hudson's Bay slope.

The greater part of the Palaeozoic section in Manitoba is made up of limestone and the greater part of this is dolomitic (magnesian) limestone. Gypsum is prominent in at least one horizon

and may be present in others. Shale is interbedded with limestone in a few horizons but most of this is highly calcareous. Little sandstone is present except in the basal Winnipeg sandstone.

Though very old geologically, the Palaeozoic beds of the province have been little disturbed from their original attitudes. True, they have suffered from several changes of elevation , but there has been practically no deformation, such as folding and faulting. The bedding planes are still nearly horizontal, with only extremely low dips to the southwest in the southwestern part of the province, and to the northeast near Hudson's Bay.

Economic Geology - No metalliferous deposits have been found in the Palaeozoic rocks of the province, and the indications are that none will be found. They are, however, richly endowed with non-metalliferous materials of considerable economic importance.

Limestone is abundant in considerable compositional and textural variety. Building stone is available from nearly all limestone sections, though much of this rock yields only small dimension stone. The bed that has assumed greatest importance as a source of large dimension building stone of high quality is the Lower Mottled limestone which has been abundantly quarried at Garson. Though widespread, this limestone is accessible in only a few places along the eastern margin of the Ordovician beds in southern Manitoba. Other limestone horizons have proved of value as sources of material for road metal, concrete, lime-burning, cement-manufacture, etc. Certain beds containing fine-textured limestone of the lithographic variety offer abundant material of various light-coloured tints that is suitable for polishing into commercial marble. These so-called marbles are available from localities between the lakes and also along the Hudson Bay railway, a few miles from The Pas.

Gypsum occurs in prominent beds in at least one geologic horizon in Silurian formations. Indications from wells are that beds of gypsum underlie considerable portions of the Palaeozoic area and that there may be other horizons in which it occurs.

Salt rises in a belt of brine springs and is produced from a deep well brine in the Neepawa district. Brines have been encountered in several wells in widely separated parts of the Palaeozoic area. While nothing positive can be said, it seems that there are possibilities for the occurrence of beds of rock salt in the provincial area.

Silica Sand is available in large quantity from the bed of Winnipeg sandstone which is so well exposed on the islands of Lake Winnipeg. This sand is of great purity and has found a market for use in the manufacture of glass.

So far, mention has been made only of known potentialities in the Palaeozoic formations of the province. In other parts of the world oil and gas have proved to be important in beds of similar age. However, in Manitoba, the sum of the evidences so far accumulated is not favourable to the finding of these materials in our limestone formations. With no formations of Carboniferous age in the Palaeozoic group, there is no hope for the finding of coal.

MESOZOIC FORMATIONS

The rocks of Mesozoic age occurring in Manitoba are assigned to the Jurassic and Cretaceous periods. The sketch-map (Figure 1) show that these formations are confined to a single area in southwestern Manitoba, where they form the bed-rock in about one-seventh of the area of the province. Good exposures of Cretaceous beds are few and largely appear in valleys and side-hills in the relatively

deeply dissected escarpment.

The Mesozoic beds have been subdivided as follows:

Upper Cretaceous	Pierre shales - Odanah series	. . . .	400 feet
	Millwood series	. . .	650 "
	Niobrara shales	. . . .	250 "
	Benton shales	. . . .	178 "
	Dakota sandstone	. . . .	200 "
Lower Cretaceous	Grey-brown shales (well section)	. . .	162 "
Jurassic	Shales (Marine and Non-Marine)	. . . .	190 "

In this classification the older beds are placed at the bottom. Thicknesses are maximum, rather than average, for the different members.

As a whole, the Mesozoic formations of the province are made up of marine deposits of shale, considerable sandstone and only minor thin beds of limestone. The chief sandstone member is the basal Dakota, which is in large measure continental in origin.

<u>Economic Geology</u> - So far, Mesozoic deposits in the province have yielded very little material of economic importance, and prospects are not bright for any great economic resources. Among the possibilities which might be considered are the following:

<u>Clays</u> and <u>shales</u> are not of a quality satisfactory for the manufacture of high-grade clay products. Some shales have been used, generally mixed with other clays, for the manufacture of brick. In places are found beds of shale with sufficient limestone to make natural cement material. Some of the more indurated shales have been used for temporary road metal.

There are possibilities for commercially important deposits of <u>bentonite</u> and <u>bentonitic material</u> of kinds which might be valuable

for oil purification, etc.

The possibilities for coal and lignite are not promising. Most of the province's Cretaceous beds are marine and, therefore, not likely to be coal-bearing. In the basal member, the Dakota sandstone, small amounts of lignite may occur, but it is doubtful if any commercial deposits will be found. Marine beds are more fruitful sources of oil and gas. Small amounts of gas have been produced from Cretaceous formations in the province, but the outlook for oil and gas is not bright.

CENOZOIC FORMATIONS

Early Tertiary beds occur in the upper parts of Turtle mountain and neighboring hills in the southwestern part of the province, close to the United States border. They contain a few thin beds of lignite, some of which has been produced commercially in recent years.

Quaternary deposits, formed in Glacial and post-Glacial times, comprise glacial drift and modified drift which provide important soils, and, in places, gravels and sands for road-making and other structural purposes. In post-Glacial times important quantities of peat have been formed in swampy areas in many parts of the province.

SUMMARY OF MANITOBA'S MINERAL POSSIBILITIES

The geological history of the province, together with collected evidences of production and experiences in development, permit the following general predictions concerning the future of the mineral industry.

Perhaps the most promising future lies in metals to be produced from the high-temperature, deep-seated type of vein deposit. The metals expected from these deposits are mainly gold, copper and zinc. Smaller quantities of silver, lead and cadmium may be produced as by-products in the development of ores of the former metals. There are potentialities in nickel and notably in the rare metals found in pegmatites, such as lithium and beryllium. Tin, molybdenum and tungsten are possibilities, and prospects of these metals are known.

Among the non-metallic minerals, the province holds great resources in building stone and gypsum. Salt from brine is available and beds of rock-salt are expected. Materials are at hand for clay-product industries requiring only low grade material and for the portland cement industry. Road-metal and gravel for roads is abundant, but not locally available in some wide areas. Feldspar is abundant in Pre-Cambrian areas. Glass-sand occurs in enormous quantity and materials like bentonite and moulding sand may yield to active search. Possibilities for an important production of fuels, coal, oil and gas, are remote. Products like gemstones, asbestos, mica, talc, verde antique marble, etc., etc., are possible, but it is too early to conjecture their latent possibilities.

PHYSIOGRAPHY AND TRANSPORTATION

The Pre-Cambrian country is more difficult to travel and less hospitable than the plains country to the south, which today is well served by highways and railroads. No topographic difficulty is presented to the mineral development of the southern area.

CHAPTER 6

PHYSIOGRAPHY AND TRANSPORTATION

The northern or Pre-Cambrian area presents complex transportation problems further increased by seasonal changes. The entire Shield area has been more or less glaciated by Pleistocene ice-sheets and the Manitoba areas show the characteristic surface features of ice-sheet erosion. The bedrock surface is hummocky with rounded hills and ridges of rock alternating with basin-like depressions and valleys. Bedrock is commonly concealed in the depressions by accumulations of glacial drift, peat bogs, swamps, lakes and streams. Even on elevations bedrock is in many places concealed by drift material and vegetation. In some areas, the covering is sufficiently thick to fill all depressions and in such areas outcrops are scarce or entirely lacking. Rock exposures may then be found only in the rapids of streams or on lake shores, where the drift has been locally removed by stream or wave erosion. Though Pre-Cambrian areas have locally a rough , uneven appearance, in a regional way there are no great or sudden changes of elevation. Rarely do the hills and ridges rise above neighbouring drainage systems by more than one hundred feet. The bedrock surface is far less even than the actual surface, owing to the fact that depressions have the greatest thickness of covering. The deepest basins are usually occupied by lakes.

Fringing the Pre-Cambrian rock formations to the southwest are flat-lying limestones of Palaeozoic age which form a wide belt extending from some distance north of Saskatchewan river to the United States boundary. Lakes Manitoba and Winnipegosis lie in the belt. Further southwest the limestones are overlain by later formations of sandstones, shales and thin bedded limestones. These formations

are nearly flat-lying with a very slight dip to the southwest. Topographically there is a gradual rise in the land surface proceeding southwest, and the north-western edges of the Palaeozoic and Cretaceous rocks have been eroded to form prominent escarpments known variously as the Porcupine, Riding, Duck and Pembina mountains. Underlying bedrock in these escarpments possesses the uniform southwesterly dip unless disturbed by local slumping, resulting from the activity of erosive agencies. A fairly thick mantle of glacial detris and lake clays covers the entire southwestern section so that abrupt changes in elevation are very uncommon except on the northwestern flanks of the Cretaceous escarpments.

While the southwestern area is well served by highway and railroad and no topographic difficulty is presented to the mineral development of the area, the northern portion of the province has taxed the ingenuity of those interested in mineral development in devising efficient and economical methods of transportation. The Hudson Bay railway extending from The Pas northeasterly to Churchill on Hudson Bay provides an artery of contact with many of the remote northern areas. Branch lines extend from The Pas to Flin Flon and Sherridon, the end of steel, some ninety miles north. These branch lines provide an excellent approach to many of the areas of mining interest. However, it is generally necessary to proceed further into the area for prospecting purposes than is accessible by rail. Canoe, dog-team and 'plane are used, with the aeroplane being the more popular means of travel to remote areas.

Lake Winnipeg during the summer provides a water route to Norway House, located at the extreme northern end of the lake and from that point prospectors proceed by 'plane and canoe to the lake

systems to the northeast. Freight is also taken by water from Winnipeg to be stored for winter transport from convenient points.

Winter freight transportation is the common practice in Northern Canada into areas not served by rail or readily navigable water routes. Tractor swings carry tons of freight over frozen lakes, muskegs and rock ridges. Nearly all the heavy plant machinery and a large amount of food supplies are carried to remote northern points in this manner. Frequently urgent heavy freight requirements are handled by 'plane during the winter season in addition to the transportation of fresh perishable commodities, but usually the cost of carrying heavy machinery by air is prohibitive unless the time factor overrules immediate cost.

ADMINISTRATION OF MINERAL RESOURCES

IN MANITOBA

MINERAL LANDS ADMINISTRATION

DOMINION OF CANADA

UNTIL JULY 15, 1930

PROVINCE OF MANITOBA

ON AND AFTER JULY 15, 1930

CHAPTER 7.

The administration of the natural resources of Manitoba was transferred from Dominion to Provincial authority on July 15, 1930, in accordance with the Memorandum of Agreement as set forth in "An Act respecting the Transfer of the Natural Resources of Manitoba", chapter 30 , S. M. 1930.

From the creation of the province of Manitoba in 1870 until 1930, mineral lands were administered under authority of the Dominion Lands Act and from 1883 on the administration was done by virtue of regulations adopted pursuant to the Lands Act. On September 17, 1889, regulations were adopted for the sale, settlement and use of Dominion lands in the province of Manitoba, (and the North West Territories), whereby all patents from the Crown for lands in Manitoba reserved forever all mines and minerals that might be found to exist within, upon or under such lands, together with the right to work such mines and minerals. The regulations came into force on January 11, 1890, and in the case of lands entered as homesteads before that date, generally, these do not contain the reservation of minerals.

Another marked change in the method of disposal of mining lands was made in 1914. Heretofore, title to such lands, except those in forest reserves or those containing petroleum or coal, was conveyed by patent, and a Crown grant was deemed to transfer and pass the surface rights and the rights to all minerals, except coal, found in veins, lodes or rock. The Dominion Lands Act, 1914, chapter 27, section 8, provides that such lands could only be disposed of by lease. The Act was assented to June 12, 1914, and the final title to a mineral claim for which entry was made on or after that date is a lease issued for a term of twenty-one years, renewable for a further

term of twenty-one years. All Mineral claims in Manitoba for which entry had been granted on or before June 11, 1914, would have for their final title a Crown patent.

Further changes were made in what were known as the Quartz Mining Regulations on April 1, 1929, when the four-line staking of mineral claims was adopted, instead of the one-line as formerly used. On the transfer of the natural resources, the province of Manitoba adhered in principle to the Dominion regulations adopted April 1, 1929.

Some years before the transfer of the natural resources to the province, the promise of extensive development in several metalliferous areas and the consequent duties devolving upon the province of controlling mining operations and fostering the industry, together with the prospect that Manitoba would soon be administering its own mineral and other resources, led to the establishing of the Department of Mines and Natural Resources on May 9, 1928.

On the creation of the Department the Honourable John Bracken Premier of the province, was sworn in as Minister of the new Department. During the previous year a Commissioner of Mines had been appointed and was attached to the Department of Agriculture. R. C. Wallace, now Principal of Queen's University, Kingston, Ontario, was made Commissioner of Mines and Natural Resources, but in September of the same year resigned and J. S. DeLury was appointed in his place.

The Honourable D. G. McKenzie was sworn in as Minister of Mines and Natural Resources on October 22nd, 1928, and was succeeded by Honourable J. S. McDiarmid, May 27, 1932.

The Mineral resources of the province have been investigated at different times by provincial bodies and authorities. These invest-

igations were notably under the direction of the Manitoba Public Utilities Commission in 1916, and later the Commissioner of Northern Manitoba and the Industrial Development Board of Manitoba. A number of bulletins, dealing with mineral resources, geological features and mining operations, were issued from time to time. Field investigations of the Department of Mines and Natural Resources have been necessarily limited to the time after its creation in the spring of 1928.

The Mines Branch aims to make through its geological work a bureau of information on all points relating to the mineral resources of the province, and in co-operating with the Dominion Departments becomes the clearing-house for the many and excellent reports and maps prepared by the Dominion.

The government of Manitoba has for many years sponsored schools for prospectors and over the years the scope of these schools has widened and the classes have been taken to other mining centres in the hope of making the people of the province more mining-minded.

The Mines Branch has now carried on for the seventh year the collection of mineral statistics and in this work it co-operates with the Mining, Metallurgical and Chemical Branch of the Bureau of Statistics, Ottawa. Early estimates of mineral production are supplied toward the latter part of each year, a preliminary report is issued early in each year and a final report at the middle of the year for the previous year, as well as the half-yearly report. Monthly reports are now being issued to the newspapers interested.

In the control of the natural resources of Manitoba, the Department of Mines and Natural Resources is divided into several Branches, one of which, the Mines Branch, has as a function the administration

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of the mineral resources under authority of "The Mines Act" and rules and regulations thereunder.

For purposes of this administration, the province is divided into two districts which derive their names from the places where the Mining Recorders' offices are located -- Winnipeg and The Pas. Each district is again divided into divisions, of which there are the following:

Districts		Divisions
Winnipeg	-	Winnipeg, Lac Du Bonnet, Dauphin, Rice Lake, Oxford Lake, Island Lake, Gods Lake.
The Pas	-	Athapapuskow, Herb Lake, Granville Lake, Cross Lake, Churchill.

"The Mines Act " was passed in 1930 to meet conditions after the transfer of the natural resources to the province. Both in the Act and in the regulations thereunder, an endeavour was made to bring about provisions such that, while doing justice to the development of the mining resources of the province, would meet with the approval of those interested in mining work, especially the prospector whose search for minerals should be stimulated rather than hindered by legislation.

It has been said that where valuable minerals exist in workable quantities, they will be mined under any possible law. While this may be perfectly true, it is obvious that a fair and reasonable regulation of the mining industry is more conducive to the economic development of the minerals. It will be admitted, too, that mineral lands should be held for development and not for speculation.

The Manitoba mining regulations as in force at present are based for the most part on practice that prevailed in Ontario, where

some fifty years of mining experience have seen mining regulations make progress by experiment.

The Regulations for the Disposal of Mineral Claims, adopted under the provisions of "The MinesAct", followed for the most part the lines adopted by the Mineral Lands Branch, Department of Interior, the features of these being:

1. Licenses necessary for prospecting and staking out mineral claims on Crown lands;
2. Four-line staking, with lines running north and south, east and west;
3. Twenty-five days' work per year for five years on each claim;
4. Each prospector limited to three claims for himself and six for other licensees;
5. Title to the claim by lease for twenty-one years after completion of representation (assessment) work, survey of the claim, and payment of rental.

MINING RECORDERS' OFFICES ----

The functions of the Mining Recorders' Offices are:

1. To issue Miner's Licenses;
2. To record the staking of claims;
3. To keep up registration of assessment work, survey, and other matters leading up to lease of the claim;
4. To record all assignments of a claim;
5. To inspect representation (assessment) work when completed;
6. To have survey plans checked by the Surveys Branch;
7. Latterly to issue lease.

The Mining Recorder's Office is a mineral claims titles office, taking the mineral claim from its entry to its title by lease, or its

abandonment; that is, its files contain all the documents having to do with the requirements of the regulations as well as those having to do with the disposition of the claim.

The Mining Recorders' Offices are conducted in a manner sufficiently simple to permit of the prospector attending to his own business in dealing with his holdings without having to resort to legal assistance, particularly in the early stages of his exploration work.

However, with all the changes made in land and mining regulations prior to the transfer of the natural resources to the Province, there has arisen the difficulty in the Mining Recorders' offices of stating quickly and definitely who, for certain lands, is the holder of the mineral rights. For this reason the person desirous of acquiring mineral rights in an old settled area in the province, is well advised to make careful inquiry and search as to the ownership. In many areas there is left to the Crown only small parcels of land under which the mineral rights are in possession of the Crown.

In the case, too, where lands have been conveyed to railways or land companies, it will be found that, while these concerns have acquired the mineral rights -- and in many instances after January 11, 1890, they have in turn, when selling the lands, not included the mineral rights in the sale. These difficulties of title do not arise in the newer and particularly the Pre-Cambrian areas, so that the administration of these newer areas is made much easier.

The Mining Recorder's office, too, is one where information relating to the validity of a claim may be searched in the records, and in this connection it should be noted that the files of the Mining Recorder's office are always available without fee to any claim-holder for search of his own holdings. A small fee is charged to others.

Together with the records of the mining claims held in Manitoba, the Mining Recorders' offices also provide a service to the prospectors and to the mining public in making it possible to obtain conveniently geological reports, geological maps and blueprints of claim locations located in the various mining divisions.

The Surveys Branch of the Department of Mines and Natural Resources prepared blueprints of mineral claim locations in Manitoba for the use of prospectors. These blueprints are kept up-to-date and assist the prospector in locating ground open for staking and also serve as a guide to his operations in the field. In their preparation a direct relationship is maintained to the national topographic series of maps compiled by the Topographical Survey of Canada from aerial photographs. They are frequently referred to as aerial or topographical maps.

MINING ACTS AMENDMENTS AND REGULATIONS

The following Acts and amendments affecting the administration of mineral lands in Manitoba have been enacted by the Legislative Assembly. Together with these are shown certain regulations adopted under these Acts:

1913 "The Mines Act," chapter 128 of the Revised Statutes of Manitoba, 1913.

1927 An Act to amend "The Mines Act," chapter 38, assented to March 23, 1927.

1928 An Act to amend "The Mines Act," chapter 41, assented to March 16, 1928.

"The Mines and Natural Resources Act," chapter 42, assented to March 9, 1928.

Rules under "The Mines Act" for mine operation, adopted November 1, 1928, by order-in-council 1142*28.

1930 "The Mines Act", chapter 27, assented to March 28, 1930. Came into force July 15, 1930.

An Act to amend "The Mines and Natural Resources Act," being chapter 42, 1928, chapter 28, assented to March 12, 1930.

Regulations under "The Mines Act" for the disposal of mineral claims, etc., adopted April 8, 1931, by order-in-council, 398*31.

"The Manitoba Natural Resources Act," chapter 30, assented to February 19, 1930.

"The Provincial Lands Act," chapter 32, assented to March 12, 1930.

1932 An Act to amend "The Mines Act," chapter 28, assented

to April 1, 1932.

Also, section 113, "The Game and Fisheries Act", chapter 15, assented to April 1, 1932.

1933 An Act to amend "The Mines Act," chapter 25, assented to April 28, 1933.

"The Mining Tax Act," chapter 27, assented to April 28, 1933.

1934 "The Crown Lands Act," chapter 7, assented to March 29, 1934.

An Act to amend "The Crown Lands Act," chapter 8, assented to April 7, 1934.

An Act to amend "The Mines Act," chapter 27, assented to April 7, 1934.

An A ct to amend "The Mines and Natural Resources Act," chapter 28, assented to March 26, 1934.

1935 An Act to amend "The Crown Lands A ct," chapter 9, assented to March 19th, 1935.

1936 Regulations under "The Mines Act" for the disposal of mineral claims and placer claims, adopted May 18, 1936, by order-in-council 495*36.

1937 An Act to amend "The Mining Tax Act", chapter 44, assented to April 17th, 1937.

"The Well Drilling Act," chapter 50, assented to April 30th, 1937.

1938 An Act to amend "The Crown Lands Act," chapter 12, assented to March 8th, 1938.

~~An Act to amend "The Mines Act,"~~ chapter 26, assented to February 25th, 1938.

An Act to ratify a certain agreement between the Government of the Dominion of Canada and the Government of the Province of Manitoba, chapter 27, assented to March 15th, 1938.

Reference may on occasions have to be made to the following Dominion Acts and Regulations:

1890 Order in Council reserving Mines and Minerals, Canada Gazette, Volume 23, Page 1360, 1890.

1908 - Dominion Lands Act, chapter 20, section 37.

1914 - Dominion Lands Act, chapter 27, section 8.

MINING

The history of metalliferous mining development lies within the past twenty-eight years.

The mining industry is today making an important contribution to the wealth of the province.

CHAPTER 8.

MINING

Mining is referred to as a basic industry. It takes its place with agriculture and lumbering, as it springs from a natural resource. Yet there is one great difference with all other industries -- it has to do with a wasting asset. The soil of the prairies will remain fertile for many years. Its wasting fertility can be revived by the addition of the proper fertilizers. Conservation can and will do much in preserving our forests for the generations to come, and great areas can be reforested with man's work assisting and co-operating with nature.

Ore may be developed and blocked out into definitely known ore reserves with the quantities and values set forth with reasonable accuracy. The mining industry is based on developed mines, that is mines which have a definite quantity of ore in sight -- developed -- as dinstinguished from prospecting ventures which have little or no ore exposed. But once that ore is removed from the natural deposit, it cannot be replaced. It is depleted forever. In the language of the accountant, it is referred to as a wasting asset, and in deductions in income tax returns, allowance is made for the depletion of ore reserves.

There are times, too, when mineral matter must remain in the ground awaiting a better price for the metal it may contain, or awaiting some method which may be worked out to permit of the mineral matter being treated profitably. And ore is only that mineral substance which is handled at a profit. Of the ore at Flin Flon or that at the Sherritt Gordon mine, the success in treatment is largely due to the flotation process which permits of the separation of minerals so intimately

associated as to be referred to as a refractory ore.

In the first instance, ore deposits have to be found. This is the "Prospecting" stage wherein is displayed the patient searching and the innate optimism of the prospector. The deposit next has to be "explored" to find out what is in it. Then follows "development" to prove the continuity and mass of the deposit. Finally there comes the "production" with its consequent "depletion" of ore.

As many conditions to arise in a mine are buried in the earth, the approach to the work of development and production should be one of conservative optimism. It is the changing conditions about a mine that frequently make for tentative works with alterations following constantly as the mining proceeds. This is particularly so in the initial stages. And much alteration, too, has to be carried on coincidentally with daily operation where new methods have been devised.

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GOLD MINES OPERATING IN MANITOBA - 1937

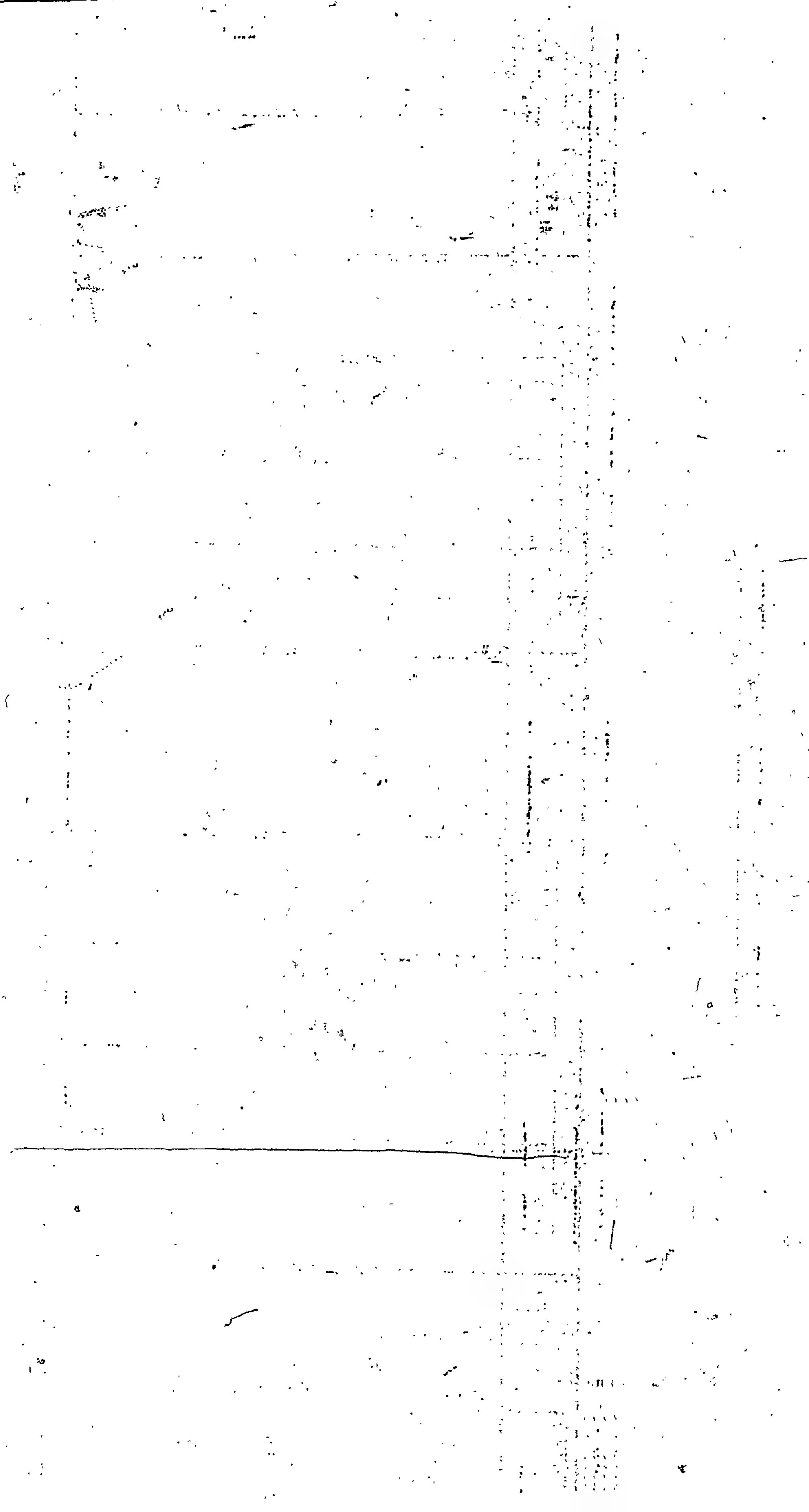
Company	Milling Capacity in Tons	Value of ore per ton	Value of Production for 1937	Ore Reserves in tons	Grade of Ore in Oz. per ton of Gold	Dividends paid in 1937	Dividends paid to date
God's Lake	185 - 200	$10.19	$ 626,640	$ 152,400	0.30		
Gunner	140 - 150	11.77	586,357	77,092 to 79,092	0.35	79,624	79,624
Gurney	125	9.45	60,200*		0.36		
Laguna	80 - 90	17.52	519,411	29,727	0.60		
San Antonio	320	9.09	1,052,574	256,516		324,544	1,237,306

*Began operations October 15/37

BASE METAL MINES IN MANITOBA - 1937

Company	Milling Capacity in tons	Grade of Ore in 1937 Copper %	Grade of Ore in 1937 Zinc %	Grade of Ore in 1937 Gold Oz.	Grade of Ore in 1937 Silver Oz.	Ore Roserves in Tons	Grade of Ore Reserves Copper %	Grade of Ore Reserves Zinc %	Grade of Ore Reserves Gold Oz.	Grade of Ore Reserves Silver Oz.	Dividends Paid 1937 $	Dividends Paid To End of 1937 $
Hudson Bay M&S Co. Flin Flon	4,400	2.17	4.7	0.107	1.52	24,770,000 *	2.10	3.86	0.08	1.28	4,826,453	10,342,399
Sherritt Gordon Mines Ltd.	1,500	2.815	..	0.189	.596	3,755,000	2.68	3.12	64 cents in gold & silver			
						910,000	1.20	...	60 cents in gold & silver			

* At December 31st, 1935.



The early stages of mining -- that is the prospecting and exploration stage -- are wholly speculative. It is at that time impossible to make any definite appraisal of the values of possibilities. And there is, too, a considerable period from the time of these preliminary operations to that of production. In these early stages, there is unavoidable uncertainty. The determination of the commercial value of the project rests with the mining engineer who has to weigh the probabilities of the financial success of the enterprise. And it must not be forgotten that in mining conditions are usually buried in the earth and to a great extent the engineer is confronted with the unknown. It will be seen therefore, that the risk of loss is great, so that the reward for success should be correspondingly great -- so the speculator says. And even apart from the speculative risks that attend a mining enterprise, large expenditures are now required to establish a mining company in production.

In the matter of prices it will be noted that the mining industry is for the most part dependent on prices prevailing in the world's markets. Manitoba's metal production is far in excess of its requirements. In fact, the same may be said of these metals in Canadian production. Manitoba finds its metals exported to all parts of the world.

With changing prices the margin of profit in mines like Flin Flon and Sherritt Gordon may be small. And if prices become unfavourable such companies cannot always cease operations.

The increase in the price of gold from $20.67 to $35.00 an ounce has lengthened the life of existing mines and of the mining communities dependent upon them. For a time it increased the profits but companies soon sought a reduction in the limit of payability.

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[illegible] the [illegible]

[illegible] It will be [illegible]

[illegible] In other [illegible]

[illegible]

There was for a time, too, considerable impetus given to prospecting and exploration but, failing new and important discoveries since 1935 and with unsettled world conditions, the prospector has not found it easy to obtain the usual grubstake.

However, as to Manitoba, it was exceedingly fortunate in that its two outstanding base metal producers were developed and prepared for production before the depression. It will be recalled that production from the Flin Flon mine was in 1929 based on:

Copper at 15 cents a pound;

Zinc at 6 cents a pound;

Silver at 50 cents per ounce.

The following are prices for metals which have prevailed for the years in which Manitoba has produced metals. The Prices, 1930-1937, are calculated in Canadian funds.

	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
Copper, cts/lbs.	27.180	24.628	18.691	17.456	12.502	13.382	14.421	13.024	14.042	13.795	12.920	14.570	18.107
Silver, cts/oz.	81.417	96.772	111.122	100.900	62.654	67.528	64.873	66.781	69.065	62.107	56.370	58.176	52.993

	1930	1931	1932	1933	1934	1935	1936	1937
Copper, cts/lb.	12.982	8.370	6.380	7.455	7.419	7.795	9.477	13.078
Zinc cts/lb.	3.600	2.554	2.405	3.211	3.044	3.099	3.315	4.902
Gold, $/oz.	20.67	21.55	23.47	28.60	34.50	35.19	35.03	34.99
Silver, cts/oz.	38.155	29.870	31.672	37.833	47.609	64.790	45.127	44.881

In this table, 1930-1937, it will be noted that while prices for the base metals, copper and zinc, were falling, gold rose from $20.67 to $34.50 an ounce and on to a high of $35.19; The United States of America forsook the gold standard on April 19, 1933, and since that time the Canadian output has been figured on prices prevailing in London, England.

In 1929, the peak price for copper was 24 cents per pound, but in March, 1930, it had fallen to $17.75 cents and by October to 9 cents. This was one month before the Flin Flon went into production.

PROSPECTING

Prospecting in northern Canada is today one of the most interesting and romantic professions a man can follow if he has the physique, temperament and intelligent training necessary for success in his occupation. The prospector is truly the pioneer of the mining industry and the future of Canadian mining is his responsibility.

The prospector must be a man of many talents. He must have a good working knowledge of geologic principles. He must have confidence in his ability to get around in all types of bush country and over water routes, living on his own resources. His temperament must be such that he does not become discouraged by many disappointments which are bound to come to him. He must have a knowledge of handling rock material with high explosives in order to prepare his property for examination by scouts of mining companies. The two most valuable qualities which he should possess are patience and observation.

Prospecting is a seasonal occupation. Rock exposures should be free from snow and ice to permit a careful examination, and consequently, the season in which an intelligent investigation of mineral areas can be made is between late spring and early fall. The dates in normal years could be set between the 15th of May and the 15th of October.

Many advances have been made in the science of prospecting during the past 30 years. Information obtained from mines operating in productive areas of the Pre-Cambrian Shield is readily available to technical investigators, geologists and mining engineers. Rock relationships which are shown to have a bearing on ore deposition are carefully studied the world over and the

various government surveys apply all this varied information to their reports on new areas. Suggestions are made to prospectors in the various areas as to the type of rock material most likely to be associated with mineral deposits. Under special circumstances, excellent application of geophysical (magnetometer and electrical) prospecting devices may be carried out by operators trained in that type of work. Dip needle prospecting may be carried out by any prospector of average ability to detect mineral zones carrying noteworthy amounts of minerals which, as a body, influence the earth's magnetic field in their locality.

The influence of underlying rock structure on topographic form has been well understood by geologists for many years. However, within recent years aeroplane travel over mineral belts has resulted in major rock structures being clearly defined and exposed for a type of inspection never before possible. Many valuable clues are to be obtained as to the salient features of a prospecting field by a flight over the area, and much wasted time can be eliminated by planning a prospecting programme from impressions gained from an aerial inspection. Conclusions resulting from such an inspection should not be regarded as final in any sense.

With air transportation firmly established as the most effective means of moving men and material into the north country, the Dominion as a whole has been rendered a great service by science. A contrast of the methods followed by the prospector of twenty years ago with those of the prospector of today in getting to a favourable field for summer operations will indicate how chances of mineral discovery should be increased by the use of the aeroplane.

It has been previously indicated that the prospecting season is limited to the period between the middle of May and the middle of

October. Formerly, prospectors desirous of entering the field would have to wait until ice had cleared from the northern water routes before leaving Winnipeg. In the fall they would have to anticipate freeze-up by at least three weeks in remote areas. The actual time spent in the field would thus be shortened by almost six weeks. This time spent in travel constituted a serious loss in a prospecting season of twenty-two weeks. The introduction of aviation as an aid to prospectors has made it possible for 'planes to land men in remote areas immediately the ice breaks up and to pick them up a day or two before freeze-up sets in. This has greatly lengthened the prospecting season and correspondingly increased chances of mineral discovery.

Prospectors, as a class, are not wealthy men. Some who have made valuable discoveries may certainly be classed as such, but generally speaking, the prospector lives from season to season depending on such employment or funds as he is able to raise to finance his trips. The interest shown in prospecting is changeable and is subject to two major influences. The prime cause of interest shown in prospecting is the interest shown in new discoveries. The lure of large returns from investments made in new territories is ever present despite unsettled world affairs or unfavourable market conditions. Secondly, when favourable market conditions are prevalent, it is not difficult to arouse interest in prospecting ventures. Consequently, it may be seen that the amount of prospecting which is done in any one season is largely dependent upon the interest shown in an area as a result of new discoveries or upon buoyant mining markets. New discoveries imply not only strikes in new territory, but also encouraging ore occurrences encountered in underground mineral development in older established areas.

In recent years, it must be admitted, there has been a tend-

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ency developing in the field of prospecting, which, if continued, will have a decidedly unfavourable result and will act as a deterrent to new developments. Experience has established that prospecting should be left to the prospector and the development of proven prospects should be left to the charge of the mining engineer or geologist. Each has a fundamental and essential relationship to the industry as a whole. In the last few years, however, owing to the aggressive search being carried on by mining companies whose treasury permits of extended field exploration, large areas of ground are optioned from prospectors immediately a strike has been made. The development of this ground is usually left in the charge of a mining engineer who may explore it either by surface trenching or diamond drilling or both. It is not any reflection on the training or ability of the average mining engineer that he has not got the temperamental requirements that go to make a good prospector. The hope, optimism and faith of a prospector, combined with an inquiring mind and infinite patience and immunity to discouragement, are the qualities required to find ore-bodies hidden under moss and muskeg. If the prospector is removed from the field as soon as original discoveries have been surrounded by the claim posts of large companies, then many of the possibilities for additional discoveries are reduced. The prospector must be recognized as the first essential factor in mineral development and every effort should be made to maintain him as such.

EXPLORATION

The first indication of mineralized rock, whether it be part of an ore-body or not, is usually seen in a rusty, decomposed

surface exposure. This material, known in Canada as "gossan", consists for the most part of decomposed rock material and iron oxides. Gossan forms from the effects of oxidation at the surface, due to weathering of the sulphide minerals in the ore. Sulphurous acid is formed from the surface oxidation of iron pyrite, the most common sulphide mineral. This acid in turn reacts on the sulphide-bearing rock and may form soluble copper and zinc salts if these metals are present. These are removed from the surface exposure so that in many cases zones which possess merely a rusty covering of iron oxide (residual from pyrite) are found to contain noteworthy quantities of chalcopyrite and sphalerite in the fresh rock below. The effect of this surface leaching on ores containing gold, which is associated with sulphide mineralization, is to concentrate gold values in the rusty zone at the surface of the outcrop. The reason for this surface enrichment of gold should be readily apparent. Gold as a chemical element is inert to naturally occurring mineral solutions formed at the surface in most cases. Under the action of surface weathering a large percentage of the weight of the material occurring at the surface is removed in chemical solution. Consequently the percentage of gold in the weathered portion of a vein is raised in direct proportion to the amount of surface leaching that has taken place since the gold is not removed in solution. Thus it may be seen that an examination of the rusted material by panning is an excellent method of ascertaining the presence of gold in the underlying vein material. Samples intended to indicate the true value of an ore-body should not contain any particles from this rusted zone; otherwise "salting" or unjustifiably high returns will occur in the assay results.

Having ascertained the presence of gold in a rusted zone, the prospector stakes his claims, following the procedure prescribed in the regulations governing the staking and recording of mineral claims. The next stage in the development of a prospect usually consists of stripping and trenching the vein to determine, wherever possible, the dimensions exposed at the surface. Pits are sunk on the vein at convenient intervals through the overburden and gossan. The spacing should be wide at the start to permit extending the vein zone as quickly as possible, and also to enable the prospector to appraise the portion of the vein most deserving of his first work. Having traced the vein for a reasonable distance, intermediate pits should be sunk wherever possible. The closer the pits are spaced, the more accurate will be the results obtained by the mining scout evaluating the property.

Pits are sunk on mineral showings first by pick and shovel to expose the hard rock surface and then by drilling and blasting into the vein until a fresh rock surface is exposed. There is a common mistake made by many prospectors in sinking their prospect pits far beyond a depth necessary to expose a fresh rock surface for sampling. A pit need only be blasted into the rock as far as the signs of rust extend. There is no justification for the belief that values will improve with depth. Values vary along the surface exposure of the vein, being at some places considerably higher than others. This is due to an irregular distribution of primary mineralization and the same condition exists in the walls of trenches. There is no reason to anticipate great changes in the mineral content of veins once the unoxidized portion of an ore-body is exposed.

Once a mineral zone has been sufficiently exposed along its length and width, the property should be thoroughly sampled. This consists of cutting a channel in the fresh mineralized rock for a uniform width and depth (usually 3 inches by 1 inch), over the width of mineralized rock. The sample may be fractioned across the width of the vein to provide an indication as to the possible localization of values along any particular wall or portion of the vein. When a sufficient number of samples have been cut, the value per foot of depth is obtained by averaging the total value of the vein over the area of the surface. Tonnage is arrived at by computing the number of cubic feet per ton of ore and dividing this figure into the volume of ore indicated by development work.

An example may be given as follows: Trenching on a gold vein at ten-foot intervals has shown the vein to have an average width of 4 feet 6 inches and a length of 480 feet. The average assay per ton in gold is .48 ounces. At a price of $35. per ounce, the value per ton of the ore indicated by surface sampling would be $16.80. The surface area of the deposit is estimated at 2160 square feet. Gold quartz ore in the unbroken state runs about one ton to twelve cubic feet. Thus the surface indicates that for each foot of depth as exposed there are 180 tons of ore valued at $16.80. Assuming a 95 per cent recovery, the recoverable value of the deposit would be $2,872.80 per foot of depth. Assuming that the deposit carries uniformly as to values and dimensions, then the maximum recovery from the deposit to a depth of 1,000 feet is $2,872,800. This figure represents the possible recovery and in no way represents the profit from the mine, as charged against this figure would be the total cost of plant and mill installation, mine development and

operating costs.

Following upon the discovery of a surface ore zone, plans are usually made for preliminary sub-surface exploration by diamond-drilling. Drill holes are directed against the ore zone at an angle that will ensure as nearly as possible a true intersection of the vein or mineralized body. Holes are directed to intersect the downward and lateral extension of ore zones at varying depths from the surface. The usual practice is to work from the known to the unknown or hoped-for occurrences.

The information gained from diamond drilling is of great assistance in planning a programme of underground development. As the drill holes have been put down usually at right angles to the direction of the formation, changes in rock and structure are usually anticipated and are thus included in development plans. Values obtained from diamond drilling holes are in no sense conclusive of values to be obtained by subsequent underground exploration in the case of gold properties. Drill information indicates the existence of values at depth and the continuity of structural and rock conditions intimately associated with the ore-bodies. Information gained from a diamond-drill campaign cannot be said to do more than indicate the presence of ore; ore-bodies cannot be blocked out by the diamond-drill method of exploration. This fact should not be lost sight of by persons interested in the development of mining properties. In the case of base metal mines, diamond-drill results provide a very close approximation to the grade of material to be anticipated in development work. With gold properties, however, very freakish drill intersections may be obtained and nothing of value is definitely assured until proven by underground methods. To be sure, good core intersections are better than poor ones, but

instances are numerous in which blank holes have passed through good lenses of ore, and conversely, holes yielding excellent core returns have been found to cut vein sections that did not make ore. Cases of this are fortunately not the rule, but they do occur and those who bargain too hopefully on drill returns sometimes feel that they have been swindled. The diamond drilling of the average gold prospect provides only a guide to future work that may be undertaken.

Diamond drilling may be done during all seasons of the year, providing an adequate water supply is available, which is usually the case. It is particularly adapted to exploration during the winter months when it is desirable to investigate veins which have been traced to the edge of a lake or large swamp. During the winter, adequate provision should be made against freezing of water supply lines for the drills. During the summer drilling is carried on in comparatively dry locations by returning the water to a sump or pit dug in more or less impervious clay.

Power for the operation of diamond drills is varied. For exploratory work in more or less remote areas, gasoline and steam obtained from locally cut timber are the main types of fuel. Surface drilling in established mining camps frequently employs the use of electric power, while underground exploration in a mine by means of diamond drilling fr quently employs compressed air.

There has been a marked decrease in the cost of diamond drilling during the last decade. Areas in which contracts were let for $5.00 per foot during 1929 now have similar work performed for as low as $1.50 to $2.00 per foot, depending, of course, upon the size of the footage contract. It must be understood that many factors, such as accessibility, timber or water supply, season,

distance of transportation, nature of rock to be drilled - all contribute to the price per foot in a contract, and consequently the above figures are not to be regarded as final.

MINING METHODS

Mine managements have long recognized the vital importance of a proper choice in working methods; they have appreciated the fact that the mining method alone may often be the deciding factor as to whether or not the mine will pay dividends. Consequently, this particular phase in any mine's history must be given careful consideration. Choice is to a great extent determined by the following aspects:-

Dimensions of vein or body;
Dip;
Nature of mineral to be mined;
Nature of walls, or of roof and floor;
Depth.

In so far as mineral deposits are concerned, mining methods in Manitoba must deal with two broad classes, namely, Pre-Cambrian and those of a younger age. The Pre-Cambrian class includes all metal-mining activities, while the deposits of a younger age embody the recovery of coal, gypsum, building stones, etc.

Due, however, to the predominance of Pre-Cambrian rock exposures, to the innumerable natural waterways intimately associated with those exposures, and to the rapid strides of modern air transportation, interest has chiefly centred on metals, and the province has primarily become metal mining in the industry.

Vein and ore-body dimensions in the operating mines vary greatly; in fact widths run from 2 feet to 200 feet, and lengths from about 30 feet to as much as over 1,000 yards. Dips are

generally steep, and, fortunately, walls are for the most part solid. Since mining in the Province is practically in its infancy, great depths have not yet been reached, and the factor of "crush" or "weight" has not seriously interfered with mining methods. Timbering is a minimum.

In number the so-called gold mines are in excess of the base metal mines, but in production the two base metal producers, Flin Flon and Sherritt Gordon, dominate all the others. It would seem that the line dividing the base metal producers from the precious metal producers is also the dividing line of the two principal working methods that have been adopted in the comparatively new industry in the Province.

FLIN FLON MINE

Flin Flon not only established a lead in the underhand, sub-level method of stoping in Manitoba, but it also set a new standard for underground scraping methods in the entire history of mechanical mining. A brief outline of this mine's operations is of interest.

The ore-body, which strikes approximately north and south, is very erratic in width, varying from about 40 feet at the 900-foot horizon to as much as 450 feet on the surface (including horses of waste rock). Two principal shafts, Main near the north end, and No. 3 at the south end of the property, service the mine. Each shaft is sunk to the 2210-foot level, and main haulageways join the shafts at the 390-, 650-, 1170-, 1690-, and 2210-foot levels, with intermediate service levels established at the 900-, 1430-, and 1950-foot horizons.

Each main haulageway, 10 feet by 10 feet cross section, is driven in the footwall and parallel to the ore-body, and from it, at 250-foot intervals, crosscuts of the same cross sections are driven into the ore-body for subsequent loading purposes. At each stope extremity supply raises are driven to join the main levels, and a "scram" or scraping drift is driven the entire length of the stope, but at an elevation of about 10 feet above the main haulageway. Thus, the boundaries of each stope are the scram drift at the bottom, a main haulageway elevation at the top, and a supply raise -- with 40-foot protection pillar -- at each end.

The supply raises are next joined, through short crosscuts, by sub-levels spaced 40-45 feet apart in the ore-body. A central raise is driven from the scram drift to connect the sub-level series, and draw raises are driven 40 feet apart between the scram drift and the first sub-level. Finally the draw raises are coned out, and the scram drift and loading crosscut below are connected by a vertical scram hole. Actual stoping operations are now ready to start.

From a central raise in the stope, a slash is taken to each wall on the second sub-level, thus forming a bench on either side of the raise. These benches were formerly carried through to the coned first sub-level by jackhammer drilling. This necessitated three separated lifts and entailed much shovelling and elaborate safety precautions. Recently, however, long-hole drilling has been brought to a practical stage and now the entire 40-foot benches are blasted electrically in one operation. In consequence of this new departure, stoping costs have been reduced considerably and working

conditions made much safer.

When stoping on the second sub-level has retreated from the central raise a safe distance, a similar sequence of operations is started on the third sub-level. This procedure is continued until all the sub-levels are in operation, and in longitudinal section the stope assumes the form of a gigantic triangle.

The blasted ore must necessarily fall into the coned draw raises spaced equally along and over the scram drift. Thus the scram drift is fed uniformly over its entire length.

Scram drift or scraping methods were not new when adopted at Flin Flon, but this northern mine set a new standard by installing scraping units of 150 horse power each. The unit is placed at one end of the drift, beyond and convenient to the scram hole, while the ropes carrying the large scraper pass along the entire drift and around a mounted sheave wheel at the other end. The ore is scraped forward to and passes over a grizzly to a scram hole into cars spotted in the haulage crosscut underneath.

A very high efficiency has been reached at the mine in this method of underground stoping. The initial costs of supply raises fitted with electric hoists and scraping units are high, but the subsequent saving is outstanding.

The upper limits of the Flin Flon ore-body are mined by open-pit methods, and here again the economy of large-scale operations has been appreciated. Since a large part of the ore-body lay under Flin Flon lake, it was necessary to dam part of the lake, pump it dry, and remove about a million tons of silt and clay overburden before operations could be started on the ore-body proper. From the outset the open-cut methods were carried on on an exceptionally

large scale, and here again the subsequent low costs more than merited the high initial outlay and daring of the scheme.

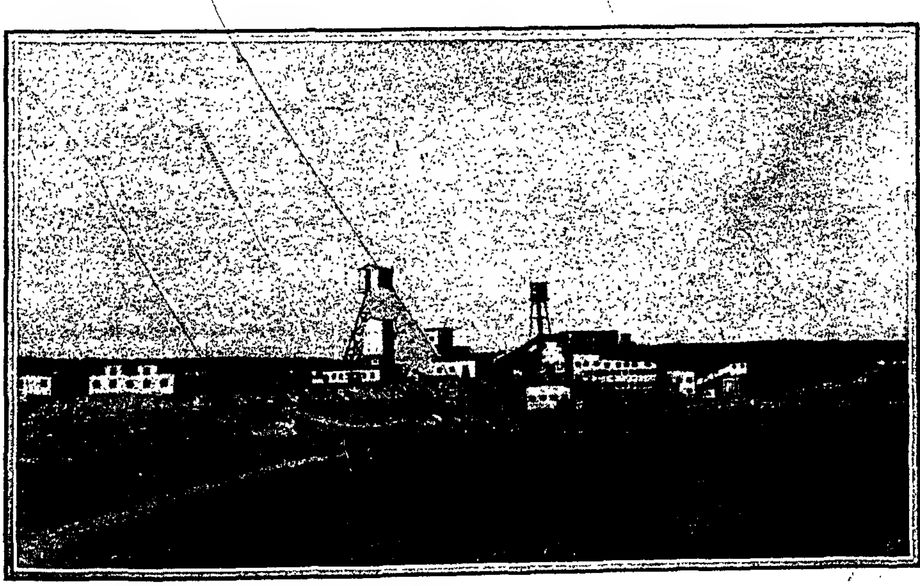
The ore-body was drilled systematically by electrically driven Armstrong drills. At the peak of operations, the holes were drilled to a depth of 54 feet at 5-inch diameter. Each hole was sprung and then the series was loaded with decked charges, hooked up in a series-parallel system and fired electrically. Incidentally some of the largest blasts in mining history were put off, one such blast containing about 150 tons of dynamite and moving approximately 750,000 tons of rock. This cheap method of mining has almost reached its depth limit, and as tonnages decrease in the pit, they are being proportionately increased in the mine to maintain an average daily output of 4,500 tons.

The entire Flin Flon operation is an outstanding example of what obstacles may be surmounted when cheap power is available. Power for Flin Flon is, of course, developed by the waters of the Churchill river, 56 miles to the north.

SHERRITT-GORDON MINE.

At Sherritt Gordon, the ore-body is not so wide, nor is its dip as steep as that of Flin Flon. Methods of stoping similar to those at Flin Flon, however, have been adopted, but in handling the ore the scram drift method has been replaced by intermittent chute feeding directly from the bottom of the stope to the cars on the haulageways. In several stopes the dip is so flat that the broken ore will not gravitate and light scraping units have to be used. Unlike any other mine in the province, the primary crushing at the Sherritt-Gordon mine is done underground, ore feed from the several levels being carried through an ore pass adjoining the main

SHERRITT GORDON MINES LTD., SHERRIDON
ROYAL CANADIAN AIR FORCE PHOTOGRAPH



SHERRITT GORDON MINES LTD.
MAIN SHAFT & MILL

shaft. Here, as at Flin Flon, electricity plays an important part in mining methods, and the same hydro-generating station that supplies Flin Flon gives power to this mine.

GOLD MINES

With little exception, the gold mines of Manitoba have adopted normal shrinkage stoping methods. This is probably due to the steep dips of the veins and the solid nature of the walls. Levels are spaced 125 to 150 feet apart and the drifts are used as haulageways. This method of working reduces waste to a minimum, for box-holes are cut at equal intervals along the drift and joined overhead. The vein is then worked overhand by carrying successive breasts along the entire length of the stope. Manways are gradually carried upwards as the stope advances, and drill set-ups are made on the broken ore. The method is economical and has many advantages. Little timber is necessary; ventilation has a continuous circulation; and, where varying values occur, ore may be drawn from any part of the stope to keep up a uniform average.

Underhand methods have also been successfully carried on in narrow veins in the gold mines of the province to overcome particular conditions. Also preparations are being made at one mine to adopt the "resuing" method of stoping, an economical modification of the shrinkage method, used in very narrow veins where some of the waste-wall-rock has to be slashed for width. The blasted waste rock is allowed to fill the stope between chutes; a temporary wooden floor is laid on top of the waste when blasting the ore; and the ore is shovelled into the open chutes.

BACKFILLING

Empty stopes will not stand indefinitely without protection, and, while there is no direct profit in backfilling, yet this operation is necessary for the safety of the mine. In Manitoba's short mining history, a lot of ingenuity has been shown in working out the cheapest methods of filling the excavated stopes with waste material. At the Flin Flon mine, where the greatest amount of backfilling has been done, raises in series were driven from the underground workings to the open pit and these were, and are being, utilized as waste filling chutes. Waste rock from the open pit and underground, that would otherwise be costly to transport to remote waste dumps, is dumped into those series of chute raises. Thus the waste disposal and backfilling problems are solved at once. In addition to waste rock, however, sand has to be transported for filling purposes in order to keep pace with the extensive excavations.

In other mines similar ingenuity is shown. Frequently the waste rock from shaft deepening operations has been kept underground and dumped into open stopes. Also backfilling from the surface has been done, by scraping methods.

NON-METALLIC MINES

The non-metallic mines of the province so far consist of two small coal-mining operations in the Deloraine area and a gypsum operation at Amaranth. In each case the pillar-and-stall method of recovery has been adopted.

In the Deloraine district the small mining operations have served a very useful purpose in supplying coal at a very cheap rate to a drought-stricken area. The coal is a low-grade lignite of the

Souris type, and it occurs in a flat seam of $2\frac{1}{2}$ to $3\frac{1}{2}$ feet thick with an overburden of 30 to 90 feet. The operators generally farm in the summer months and mine in the winter months when the coal is needed; and the miners are drawn from the labour of the neighbouring farms in the winter season when they would otherwise be idle.

Equipment is crude, but consistent with the other natural conditions existing in the neighbourhood. Stalls are driven 18-20 feet wide and pillars are generally about 40 feet square. Due to the friable nature of the roof, and to the shallow overburden, the entire workings have to be heavily timbered, but timber is procured at a minimum cost from the nearby bush. In an attempt to increase production, the longwall method of working was tried at one of the mines. Due, however, to lack of experience with conditions that were far from ideal for this system, the trial had to be abandoned.

The gypsum mining operations at Amaranth and Gypsumville are seasonal and small, but they completely serve a limited market. Mining costs both in mining and quarrying are a minimum. The gypsum deposits are of considerable extent and easily operated. In mining stalls are driven 22 feet wide and pillars are left 20 feet square. No timber whatever is used. At Gypsumville the gypsum is quarried.

Due to the fact that it is one of the youngest provinces in Canada's metal-mining industry, Manitoba has started off with the advantage of the experiences of the others, but having made a good start, it is not content to play "follow the leader". In several instances, it has not only led the way in Canadian mining methods, but in new departures in the entire history of mining methods. This is notable at Flin Flon in the maximum use

of supply raises, the perfection and large-scale accomplishments of underground scraping methods, and the gigantic blasting methods adopted in the open-pit.

Other Canadian provinces are presently battling depth problems at horizons not yet reached in Manitoba. No doubt these problems will be successfully overcome, and Manitoba will in time profit once more from the experiences of others.

DEPTHS OF SHAFTS IN MANITOBA

Flin Flon	- Main	- 2210 feet
	No. 3	- 2210 feet
Sherritt Gordon		- 1050 "
Gurney		- 652 "
Laguna		- 1150 "
God's Lake		- 950 "
San Antonio	- Actual Shaft	- 1050)"
	No. 2 winze	- 500)"
Central Manitoba	-Kitchener	- 905
	Hope	472
Gunnar	- No. 1	- 1250
	2	- 275
Beresford Lake		- 500
Diana		- 775
Packsack		- 525
Gold Lake		- 325
Century		- 288
Ministik		- 225
Bergold		- 125
Sunbeam Kirkland		- 300

MILLING AND SMELTING

The ores at the base metal properties were large but low-grade and the gold ores were of moderate grade. The properties were far removed from transportation facilities and industrial centres. Hydro-electric power was required, metallurgical processes had to be worked out.

CHAPTER 9.

MILLING, SMELTING AND REFINING

The metallic ores mined in Manitoba are of two general types, considered from the point of view of methods of extraction of the constituent metal. These types are:

(1) Base metal ores, such as are mined at the Flin Flon and the Sherritt Gordon mines;

(2) Gold-quartz ores, such as are mined at the San Antonio, Gunnar, Oro Grande, God's Lake, Laguna and Gurney mines.

COMMINUTION

The milling of either type of ore begins with crushing which is followed by grinding to reduce the ore to such fineness that the valuable portion is broken away from the valueless material or gangue. And particularly in the case of the second type is the grinding done in order that each particle of the precious metal may be exposed as much as possible to the leaching action of the cyanide solution used. The liberation of the particles in an ore, accomplished by this crushing and grinding, is spoken of as comminution, and practice has demonstrated that this is best carried out in several stages with various types of machines best suited for each particular task running in series. Undoubtedly the most important factor in the crushing and grinding is to avoid any excess and unnecessary comminution, for, in addition to wasting energy and consequently money in unnecessary work, the properties of the ore for treatment are impaired. The fineness of the grinding depends upon the ore itself and is learned by experiment.

In a general way, the crushing and grinding of an ore of either of the types mentioned do not vary greatly in method, though the range over which mineral particles may be liberated from their ores

varies greatly.

The crushing is usually done with the ore in a dry condition, while grinding is done wet, water being added for the first type to form the pulp and water or cyanide solution for the second type.

Present-day grinding practice is closely linked with classification, an operation in which the finely pulverized pulp is divided into two products spoken of as (1) sand, and (2) slime. The former is the comparatively coarser and, if allowed to settle in the fluid, would do so the more rapidly; whereas the slime is the comparatively finer and more slowly settling portion. Classification, then, is the operation which separates the solid constituents of a flowing pulp into these two portions in accordance with their respective settling rates. Usually it implies the removal of a finished product referred to as "overflow" or "slime" from the product requiring further grinding and termed "sand".

In grinding the mill may operate in what is known as an open, or a closed circuit. In the former the desired reduction is produced by a single passage of the material through the grinding machine. In a closed circuit the discharge from the grinding mill is separated by the classifier into a finished overflow product and a non-finished sand product, which is returned to the mill for further grinding.

Crushing is done in jaw crushers, gyratory or cone crushers, or rolls. Jaw crushers consist essentially of two crushing surfaces set nearly vertically, one fixed, the other movable and caused alternately to approach and recede from the fixed surface.

The gyratory crusher consists essentially of a fixed crushing surface in the form of the frustrum of an inverted cone around the

axis of which gyrates a movable crushing surface, which has the shape of a conical frustrum in erect position. The material to be broken is fed into the downwardly-converging annular space between the two crushing surfaces. It is crushed when surfaces approach and the crushed material falls through when they recede.

Rolls are used for finer crushing. They consist essentially of two cylinders mounted on horizontal shafts which are driven in opposite directions so that corresponding points on the cylinder faces above the horizontal plane through the shaft centres are moving toward each other. Beneath the rolls a hopper is provided to guide the discharged material away for further treatment.

Fine-grinding machines are those that deliver the finished product well under a millimetre in maximum size. Among the machines used are cylinder mills, such as ball, conical ball, tube and rod mills, which consist essentially of hollow containers of circular cross-section and of cast-iron or cast-steel construction, mounted with axis substantially horizontal and partially filled with crushing bodies that are caused to tumble, under the influence of gravity, by revolution of the container.

In ball mills the cylinder has a large diameter as compared with its length, while in the tube mill the length of the cylinder is considerably greater than the diameter.

In the conical ball mill the principal difference between it and the so-called ball mill is the shape of the shell. The design is such that as the size of the material in the mill diminishes towards the discharge end, the crushing forces should likewise be diminished. The shell, therefore, is more perfectly described as

cylindro-conical.

In all these mills steel balls are used, the balls varying in size according to the work required of them.

The rod mill consists of a heavy steel cylinder usually with a length two to three times the diameter, filled with rods up to somewhat below the mill axis, and slowly revolved.

With the ore ground to the fineness required, the base metal ores of Manitoba are next treated by the flotation process, while the gold-quartz ores are treated by the cyanide process. It is now proposed to discuss these processes, but before doing so it is advisable to describe more fully the ores to be milled.

SHERRITT-GORDON ORE

First, that of the Sherritt-Gordon mine, a coarse-grained mixture of iron, copper and zinc sulphides, with included quartz, feldspar and mica gangue, has its various minerals well crystallized and easily cleavable. Pyrrhotite is the common iron sulphide, though pyrite does occur to some extent. Gold and silver are present in small quantities (about 75 cents a ton) and for the most part are recovered from the chalcopyrite.

Owing to its texture, the ore, when ground so that 65 to 70 per cent of the material will pass through a 200 mesh sieve, gives satisfactory results in further treatment by flotation. It will be seen in comparison with the Flin Flon that the Sherritt Gordon ore does not require as fine grinding.

At present the Sherritt Gordon mine is producing from what is known as the west orebody which has an average zinc content of 2.10 per cent. No attempt is as yet being made to save the zinc sulphide,

though re-treatment of tho tails may be done later to make this saving. The separation of the zinc sulphide involves a difficult problem and the present price of zinc does not warrant the saving of the sulphide at this time. The treatment given is simply for the extraction of the copper sulphide as a concentrate, which in turn is shipped to the Flin Flon smelter for further treatment.

FLIN FLON ORE

A general analysis of the Flin Flon ore shows that it is composed of pyrite (an iron sulphide), chalcopyrite (a copper sulphide) and zinc-blende (a zinc sulphide), together with gangue (the worthless material). Primarily it is a copper-zinc ore with which are associated considerable values in gold and silver and such other elements as cadmium, selenium and tellurium in lesser quantities. Generally, the texture of the mineral is fine and the minerals are intimately associated with one another. This, in the first instance, calls for exceedingly fine grinding and, in the second instance, for a somewhat complicated treatment in the flotation.

GOLD ORES

Turning next to the gold-quartz ores, or those of the second type cited earlier in this description of milling and smelting, the comminution of the ore follows along much the same lines as does the base metal ore. In the preparation of a gold-quartz ore for treatment by the cyanide process, the grinding required is that which will expose each particle of the precious metal contained in the ore as much as possible to the leaching action of the cyanide. As typical of this grinding of a gold-quartz ore, that of the San Antonio mine may be mentioned, where grinding is carried on at 30 per cent moisture, and 95 per cent of the resulting material from grinding would pass

through a 200-mesh sieve and 72 per cent through a 325-mesh sieve.

FLOTATION

In the milling of base metal ores at Flin Flon and Sherritt Gordon the flotation process is used. The word "flotation" is defined as "the act or state of floating".

As flotation in the milling of minerals involves the use of a bubble, a quotation from "The Story of the Bubble" by Professor G.A.Gillies of the University of British Columbia, is given, as the reader will find therein an interesting introduction to the art of flotation as applied in the milling of ores of today:

> "We can all recall scenes of children equipped with saucers of soapy ~~water~~ and old clay pipes, sitting on door steps amusing themselves blowing bubbles. We remember the pleased expression on their faces as they watched the scintillating spheres float for a few minutes in the bright sunshine, then suddenly burst and disappear. But there are other scenes of bubble blowing that are not so familiar to most of us. These had their origin about the beginning of this century in the laboratories of Europe and America. In these laboratories staid scientists could be seen solemnly blowing bubbles all day long and the extraordinary part of it was that they were being paid for doing what the children did for fun. However, strange as this may appear, the above facts are true, because the leading scientists of the world have been busily engaged for over a third of a century trying to wrest from nature the secret of bubble control. It has been a long and tedious research which has at length culminated in man's complete control of the bubble, thereby enabling him to transform his age-long plaything into a very efficient servant."

The flotation process, then, has much to do with the common ordinary bubble, which is defined in the dictionary as "a small vesicle of water or other fluid inflated with air or other gas and floating on the surface of the fluid". The dictionary has further to say that the bubble is anything which wants firmness, substance

and permanence, and the dramatist has said of it,-

"And thus we are; and all our painted glory
A bubble that a boy blows into the air
And there it breaks".

To-day those men following ore dressing operations make bubbles for the specific purpose of floating some minerals while allowing, and even forcing, others to sink. The bubble which once was elusive is now controllable and metallurgically is proving anything but a delusion. The firmness or the permanence of the bubble responds willingly to the call of the metallurgist and the co-operation has fortunately proved successful.

And so much so that Professor Gillies in his " Story of the Bubble" refers to the bubble in a kindly way: " It has changed," he says, "it has reformed and has forsworn the old carefree path of pleasure. It has joined the working class and has become a useful and industrious bubble".

The term "flotation" has come into the metallurgist's language. In the milling of ores it may be described as the process of concentration which employs a froth or bubble to float the heavy metal-bearing mineral away from its gangue (or valueless material) of rock-forming minerals. The process may be divided into two main divisions:

(1) The formation and control of the froth;

(2) The control of the surface energy of the different minerals in the pulp in order that the minerals may be induced to adhere to the bubble or repel it as may be desired.

We have, then, a separation of the mineral particles from each other in a liquid pulp by means of air bubbles. In the flotation process the finely ground ore (including the valuable mineral and the

valueless gangue) is agitated in water with the addition of air or other gas. Frothing reagents are added for the production of the bubbles. In most cases these reagents are oils or oily substances. In practice to-day the most widely used frothers are pine oil and cresylic acid, the latter gaining at the expense of pine oil.

Chemical reagents are also added to cause the mineral particles to attach themselves to the air or gas bubbles. In other cases reagents are used to aid in preventing some mineral from floating. Thus it is that we have in the flotation process such terms as frothers, collectors, promoters, depressors, activators, regulators, conditioners, etc.

The finely divided air bubbles carrying the mineral particles rise to the surface (similar to the action of a balloon), where they are removed in a froth which is known as a concentrate. The valueless gangue material does not attach itself generally to the bubbles and is discarded as a tailing or waste at the end of the machine.

The weight or specific gravity of the minerals is not the determining factor in flotation. That is, the minerals floated are most often two or three times as heavy as the gangue, and some of the heavier materials (for example lead) are the easiest of minerals to recover by the flotation process.

Of the flotation process it has been stated that it has revolutionized the mining industry. It has brought into production many properties whose ore, prior to its use, could not be successfully concentrated by gravity methods; it has enabled many properties to continue producing which otherwise would now be closed. Each year sees its scope extended.

MILLING AT FLIN FLON

The Flotation Process has been described generally, but the purpose of the short resume is to follow the ore through the Flin Flon mill from the time it reaches the surface from the mine.

In the preparation of ore for further treatment at Flin Flon, the massive material taken from the mine is first reduced in size to 6 inches in a large gyratory crusher which will handle pieces up to 42 inches in size. This is followed by another reduction in Symons cone crushers where the particles are reduced to 1 inch in size. A further crushing reduction is made in rolls where the pieces are broken down to particles of $\frac{1}{4}$ inch in size. This completes what is usually referred to as crushing and the ore up to this point is handled dry.

Automatic weighing and sampling follow before the ore is conveyed to mill bins from which it is drawn for grinding in Hardinge conical mills, 10 feet by 66 inches. Water is added to form a pulp and the grinding is done by the tumbling of 3-inch steel balls which cascade as the mill is revolved. Each mill has a load of 28 tons of these balls and 1930 pounds has to be added daily to keep up the standard load. This daily addition represents the daily loss of metal worn off in the attrition, and passes from the mill with the ore now ground as much as to 60-70 per cent 325 mesh, which means that the material entering the mill at $\frac{1}{4}$ inch size leaves it ground to .0017 inch size.

Now, this ore reduced to a fine powder has in it three minerals which it is desired to separate from the pulp. Here the Flotation

Process begins at Flin Flon. The separation is referred to as selective or differential.

The pulp from the grinding mills and the necessary reagents are fed to machines referred to as Mineral Separation-Sub A flotation cells.

These are a series of square boxes in which agitation is produced by rapidly revolving impellors and addition of air through a porous bottom in the cell. A heavy froth created rises to the surface and is scraped off by revolving scrapers.

Pine oil is the first reagent used. It is a frother but with the Flin Flon ore, where necessary, a floatable rock mineral locally referred to as "talc" is removed preliminary to the copper flotation. The removal of this material is the reverse of ordinary flotation in that a barren material is the concentrate, while the tailing carries the values. It may be pointed out at this time that this talc is a non-metallic mineral and, while it has no commercial value at Flin Flon, it gives an inkling of the possibilities that lie in the flotation process, for the first development of the process was in the handling of metallic minerals or those having a metallic lustre.

In the copper flotation, maximum extraction of gold, silver and copper is aimed at, rather than the production of high-grade concentrate, as it has been found that a considerable amount of gold and silver and some copper are tied up very intimately with the pyrite. The reagents used in the copper flotation are Aerofloat 25 and Minerec B. These are chemical promoters of the dithiophosphate or dithiocarbonate (xanthate) groups. The function of a "promoter" is to increase the attachment of the particular ore particle and the bubble. The copper concentrate scraped off as a froth is de-watered, and then conveyed

to copper roasters for a preliminary treatment before smelting.

The tailings from the copper flotation cells are next treated in similarly constructed cells for the separation of the zinc minerals and the reagents used are lime, copper sulphate, xanthate and cresylic acid. The lime, used to neutralize free acid, is also a retarding agent as it prevents the flotation of the less easily floatable pyrite. Copper sulphate is an activator whose function it is to impart to the non-lustrous mineral, sphalerite, the metallic lustre which flotation seems to require. The copper precipitates a film of copper sulphide upon the zinc mineral and thus causes it to float. The iron sulphide (pyrites), on the other hand, is not filmed by the copper sulphate to the same extent. Reference has been made previously to the action of xanthates and cresylic acid.

The zinc concentrate in the form of froth is scraped off the cells and then de-watered before being conveyed to zinc roasters for treatment, preliminary to passing to the zinc leaching plant.

The tailings from the zinc flotation, or the iron pyrites, are passed to the cyanide plant for further treatment, since in these tailings there are considerable values in gold and silver. The cyanide process is discussed in dealing with the milling of gold-quartz ores and in general the leaching of the gold and its precipitation follow along the same lines. However, as the gold extracted in the cyanide plant at Flin Flon is in a low-grade precipitate containing about 45 per cent copper and a considerable amount of selenium and tellurium, it is considerably cheaper to pass this precipitate to the smelter for inclusion with the blister copper than to melt it as is ordinarily done for the production of bullion.

The Cyanide Process

The Cyanide Process as used in the treatment of gold-quartz ores is a chemical method of extracting the gold from the ore. It is the practical application of a discovery made by L. Elsner, a German chemist, in 1846. He enunciated the fact that oxygen plays an essential part in the dissolving of gold, silver and some other metals in cyanide solutions.

The fundamental operations, as carried out in the cyanide process, may be classified as follows:

(1) Preparation of the ore for dissolving -- this includes crushing, grinding, and classification which have already been discussed;

(2) Dissolving of the gold by means of a weak solution of sodium or calcium cyanide, assisted by the addition of oxygen in the form of air, and neutralized by lime;

(3) Separation of the gold-bearing solution, referred to as pregnant solution, from the leached solids;

(4) Precipitation of the gold from the pregnant solution, in the form of a black metallic sludge, by means of zinc dust;

(5) Clean-up of the sludge, and melting to form gold bullion.

The dissolving of the gold, as mentioned above (2), is expressed in Elsner's formula as follows:

$$2\ Au + 4\ NaCN + O + H_2O = 2\ AuNa(CN)_2 + 2\ NaOH$$

This stated simply, means that if a gold-quartz ore is dumped into a tank containing a weak cyanide solution and then agitated to allow air to circulate, there will be formed a gold-sodium-cyanide, $AuNa(CN)_2$, and some caustic soda, NaOH. That the cyanide solution is a weak one will be seen when it is stated that to form the solution

1 pound of cyanide is dissolved in a ton of water.

Gold ores are usually acid in condition, or tend to become acid during the course of treatment. For this reason lime is added as a neutralizing agent. It also assists in the settling of the solid particles in the solution.

Agitation as a means of adding air to the solution has been referred to and it is in this operation that a contact is effected between the finely pulverized ore and the cyanide leaching solution. As the term implies, the pulp (ore and cyanide solution) is kept in movement to maintain the solids in suspension while dissolution of the gold is taking place, as well as to entrain oxygen.

Control of aeration during agitation is essential, as excess air usually causes greater consumption of cyanide with no increase in extraction of gold. The length of contact of cyanide and ore and the dilution during agitation vary with the different ores. The time varies from 16 to 48 hours with an average of 30 hours. Dilution varies from 1 of solution to 1 of solids (ore) by weight to 3 of solution to 1 of solid, with an average of 2 to 1. In modern practice the operation of agitation is made continuous through a series of agitators, preferably three or more.

There is agitation in any part of the operation where the pulp is kept in movement, such as in the grinding circuit and in the flow of the pulp from one tank to another, but special devices for greater agitation are included in the milling operations and may be either pneumatic or mechanical in method -- of which the Pachuca tank and the Dorr Agitator are respectively typical.

In the control of the density of the pulp, Thickeners are used. In this device a portion of the liquid is removed from the pulp. This

is really a means to concentrate a relatively dilute mixture into a thicker pulp and in modern practice the thickening is made a continuous operation.

At this point there remains the solution pregnant with gold, and the leached solid. The pregnant solution is here filtered off (3) and the leached solids disposed of as waste. Next the pregnant solution is clarified in order to permit of effective precipitation to be done by zinc dust added in regulated quantity. As will have been noted previously, the dissolving of the gold was best done when air was added, but in the precipitation of the gold the operation is reversed and the best results are obtained if the air is removed. The combination of the addition of the fine metallic zinc and the removal of the air is known as the Merrill-Crowe process of precipitation. After precipitation of the gold, the solution referred to as barren solution, but which contains cyanide available for re-use in the plant, is pumped to storage tanks. It is not to be taken from this that there is no loss of cyanide in the operations. There are mechanical and chemical losses and, too, the solution becomes fouled by cyanicides such as traces of copper in the ore.

The gold precipitated as a black metallic sludge, somewhat moist, is taken from the precipitation tank and is conveyed to a plate-and-filter press where the remaining cyanide solution is pressed out and returned to a storage tank for re-use in the mill. To the sludge, now free of cyanide, certain fluxes, such as soda ash, borax and silica which vary with the composition of the precipitate, are added. The whole is melted in an oil tilting furnace. The metallic button obtained from this operation may be given a further refining with fluxes and from this is obtained a gold bar which is shipped to

the Royal Canadian Mint at Ottawa, Ontario, for further refining and the separation of the silver that is associated with the gold.

Roasting

It will be recalled that in previous descriptions of the Flin Flon ore, there was mentioned that the ore minerals separated are chalcopyrite (copper sulphide), sphalerite (zinc sulphide) and pyrites (iron sulphide); and at the Sherritt Gordon there are the same minerals but that at present only the copper sulphide is being recovered.

Up to the time that either a copper concentrate or a zinc concentrate leaves the flotation plant, no heat treatment has been applied. We have now reached a point where the sulphur contained in the concentrate has to be removed. This, like previous operations, has to be done in several stages.

To begin with, at Flin Flon the zinc concentrate from the flotation mill is conveyed to zinc roasters. The copper concentrate, on the other hand, is conveyed to bedding bins where a silica flux is added to assist fusion in smelting by forming more fusible compounds, and then the concentrate and flux returned to copper roasters.

The roasters are cylindrical furnaces in which a centre column revolving slowly carries air-cooled cast-iron arms to which rabbles are fitted above each hearth (which are arranged in decks). The concentrate is scraped or rabbled from the outside of the hearth to the centre, or vice versa.

After roasting, the methods of further treatment of zinc and copper are so entirely different that a description will be given separately as to what happens first in the zinc plant and next as to the copper smelter.

Zinc Plant

The zinc plant is divided into four main sections: the roasting plant, the leaching plant, the electro-deposition department or tank house, and the melting department or casting plant.

The function of the roasting plant is to convert the relatively insoluble zinc sulphides into compounds which can be dissolved in acid of a strength practicable for plant use. In the roasting most of the sulphur is burned to gas which is discharged from the roasters, and at the same time an endeavour is made to produce as much as possible of the contained zinc in the form of zinc oxide with just sufficient zinc sulphate to supply the sulphate requirements of the plant which operates on what is known as the low density or standard sulphate process in which the zinc is carried through the plant solution circuit attached to the SO_4 or sulphate radical, at a low concentration.

The loaching plant has two functions, first to leach or dissolve the zinc from the solids, and, second, to purify the zinc solution of substances deleterious to the deposition of zinc in the tank house. The process in the leaching plant may be described briefly as follows: the roasted concentrate, or calcine as it is called, is leached with a weak sulphuric acid solution so that the resulting leach solution contains a high zinc content but a very small proportion of the impurities. The solution is separated from the solids and is purified further by agitation with zinc dust to remove copper, cadmium (extraction of this metal will be discussed later) and cobalt. This purified zinc sulphate solution is then pumped to the electrolytic department. The solids from the first leach are again leached, but this time with a stronger acid solution to dissolve all of the remaining zinc which is soluble in the strength of acid available.

The solids and solution from the leach are then separated. The solids are stock-piled for further treatment at some future date and the solution, carrying a relatively high amount of impurities, is sent to the first leach, where the chemical action is such that the contained impurities are precipitated as solids.

In the tank house, the zinc is removed from the solution by electro-deposition. The electrolytic department is nothing more than a large number of electroplating cells in which the zinc is plated on aluminium sheets or cathodes. Since zinc does not plate tightly to aluminium, the zinc plating or sheet is easily stripped from the aluminium and the sheets are collected to be melted and cast into the standard market bars or slabs. In the electro-deposition cells, the zinc sulphate ($ZnSO_4$) is split to metallic zinc (Zn) which plates out, the sulphate (SO_4) which combines with the hydrogen of the water of the solution to form sulphuric acid (H_2SO_4). When one pound of zinc is deposited, about one and one-half pounds of sulphuric acid are formed. This acid is sent to the leaching section, where it dissolves one pound of zinc from the calcine. The solution is purified and is again pumped to the plating cells. The solution travel forms a complete circuit.

The metallic zinc from the tank house is next melted in a reverberatory furnace, dipped from the furnace in hand ladles, cast to commercial slabs, weighed and loaded on railway cars for shipment.

Three grades of zinc are produced: first, Hudson Bay Four-Nines-Plus, which is a die-casting grade of a purity guaranteed to be above 99.99 per cent zinc and generally used for die-casting alloys and for other applications where an extremely pure product is desirable; second, a Hudson Bay Electrolytic grade, a very high purity

product which is used in the production of the finest grades of brasses for the deep-drawing of artillery shells, the highest grade of zinc oxide, and so forth; and, third, a Hudson Bay Prime Western grade, which is practically the equivalent of the Electrolytic grade with about one per cent of chemically pure lead added. This leaded zinc is used for galvanizing and as a constituent of most grades of ordinary "casting" brass.

Cadmium

In the zinc leaching operations a cadmium sponge is recovered and then refined. The cadmium occurs in the ore as an earthy coating associated with the zinc minerals. While the total recovery is small in comparison with the amount of zinc obtained, the company has carried on research work and has developed a process whereby the metal is now extracted on a commercially profitable basis.

Cadmium is used in the manufacture of silverware, in electro-plating, for rust proofing, for easily fusible alloys, as a substitute for tin. Calcium sulphide makes a bright yellow pigment.

Owing to high melting point and wear resistance, it is a preferred material for bearings of high-compression-type engines.

Recent developments have proved it very useful in lead-cable sheathing because of its properties in making alloys.

Smelting

At this point we shall resume the description of the treatment given the copper concentrate after it leaves the roasting furnaces. Further heat treatment is given in a reverberatory furnace in which the copper calcine is submitted to the action of the flame without contact with the fire. These furnaces consist essentially of shallow basins which hold the charge and the layer of covering slag

while the heating flame plays over the charge and against the furnace crown. At Flin Flon the furnace is equipped with pulverized-coal burners and to the feed pipe, bringing air under low pressure to the furnace, there is fitted a piece twisted in the form of a spiral to give turbulence to the flame which passes upward over a low wall or bridge, strikes the roof (arch) of the furnace, and is reverberated downward upon the charge. The arch of this furnace is of magnesite brick construction.

The final result of the fusion in this furnace is two products:

1. Slag -- a vitreous refuse containing the earthy portions of the ore and iron;
2. Matte -- a crude copper metal combined with more or less sulphur, requiring to be further purified.

Gold and silver are also quite thoroughly collected in a copper matte, where they are chemically of little moment, though they are of real commercial importance.

The separation of the matte and slag depends mainly upon the difference in their specific weight. The slag is run from the furnace down a launder and conveyed to a waste dump in electrically-dumped, cast-steel slag pots. The matte is tapped to ladles and taken by an overhead crane to a converter which is a cylindrical retort of steel construction lined with magnesite brick. Air is blown through the molten copper matte in the presence of free silica; the iron is oxidized to form a slag with the silica, while the sulphur is oxidized and passes off as sulphur dioxide, SO_2. When the deoxidizing is completed, the converter is tilted and the blister copper poured into ladles and carried by overhead cranes to the casting department where it is moulded on a casting wheel into blister copper bars weighing

about 420 pounds each. Those, after trimming, are shipped to the Canadian Copper Refineries, Limited, at Montreal East, Quebec, for final refining of the copper and for the recovery of the gold and silver, and also selenium and tellurium which, occurring as they do with the copper sulphide of the ore, are present in small amounts.

Selenium is used in the glass industry as a decolorizer, as well as for giving glass a clear red colour useful in railway work. It is used in the ceramic industries for the production of red enamels and red enamelled steelwares. Its use in vulcanized rubber increases resistance to abrasion. It is valuable, also, as an oxychloride, a solvent for natural and synthetic resins, fish oils, etc.

Metallic selenium is a non-conductor in the dark, but on exposure to light its electrical conductivity is proportionate to the intensity of the light falling upon it. The remarkable electrical properties of metallic selenium have led to the development of the selenium cell whereby one can over the telephone hear a ray of light falling upon a metallic plate. Other electrical contrivances are rendered possible by this selenium cell.

Tellurium is a poor conductor of heat and electricity. No extensive use of this element has as yet been made. It finds use, however, in wireless equipment, since metallic tellurium has some merit as a rectifier or crystal detector. It could be used in the form of diethyl telluride as anti-knock material in motor spirits, but has been superseded by lead tetraethyl. In a limited way it is used in colouring glass or porcelain, developing brown, blue or red shades. Acid solutions of the dioxide can be used as a dip for silver ornaments, giving a platinum finish to the metal. Soluble tellurium compounds are utilized in toning baths of photography.

The Cottrell Dust Precipitation

The smelter gases, particularly from the roasters and convertors, carry considerable dust containing valuable metal. Where this dust does not settle in the flues it is precipitated by the Cottrell method and a great saving is made. This method depends upon the fact that fine particles of dust from the fumes and suspended in air, when electrified, rapidly coalesce into particles which are heavy enough to settle. Electrification is produced by a high tension discharge.

The dust is shaken off the discharge and collecting electrodes by means of pneumatic hammers. The recovered dust is drawn off periodically by screw conveyors into charge cars and returned to the reverberatory furnace.

Ores to be treated in Canada

Section 9 of "The Mines Act" requires that ores and minerals shall be treated in Canada and reads as follows:

"9. (1) All permits or leases issued under the provisions of this Act, shall be subject to the provision that all ores or minerals mined from locations described in such permits or leases shall be treated and refined within the Dominion of Canada so as to yield refined metal or other product, suitable for direct use in the arts without further treatment; in default whereof the permit or lease issued for such lands shall be and become null and void, and the said lands shall forthwith revert to and become re-vested in the Crown, freed and discharged of any interest or claim of any other person or persons whomsoever, and shall be open to disposal in such manner as the Minister may decide.

" (2) The Lieutenant-Governor-in-Council is hereby authorized to exempt any lands from the operation of this section for such period of time as to him may seem proper."

RECORDS OF MINERAL PRODUCTION

In its early history, the mineral production of Manitoba was entirely from the non-metallics. The situation has changed with the production of copper, zinc, gold and silver from the mines in the Pre-Cambrian areas.

CHAPTER 10

RECORDS OF MINERAL PRODUCTION

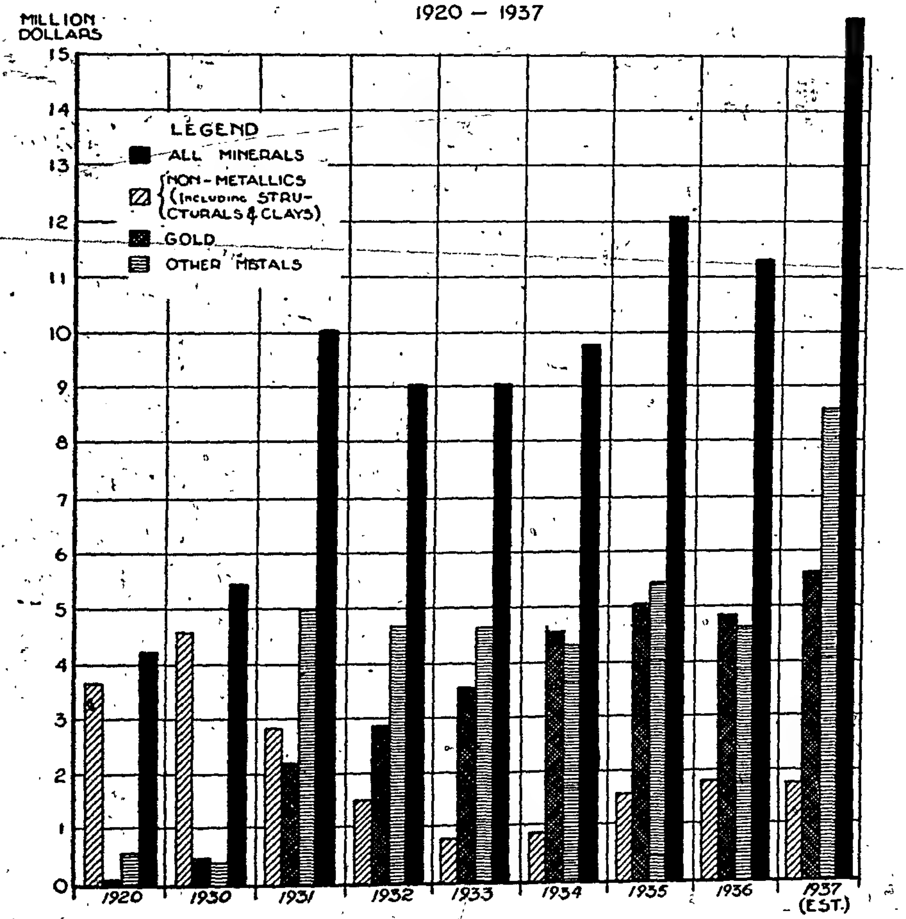
Prior to 1928 there was no attempt made by provincial authorities of Manitoba to keep a record of mineral production. Records had been kept, however, by Dominion Government Departments, chiefly the Mines Branch, but until 1907, Manitoba's production was grouped with those of Saskatchewan, Alberta and Yukon. Since the Dominion Bureau of Statistics took over the work, the compilation of mineral statistics has been the care of the Chemical, Mining and Metallurgical Division of the Bureau and each year a report on the mineral production of Canada has been issued by the Bureau, containing the details of each mineral product in each of the provinces, including Manitoba.

Until the year 1917, all the recorded production was from non-metallic minerals, chiefly cement, clay products, gypsum, lime and stone. During the period 1917 to 1920, the Mandy copper mine was shipping ore and the production tables for those years reflect the importance of copper production as well as, but to a smaller extent, gold and silver.

Gold mining was active in a small way since 1917 up to the end of 1927, and small productions of gold and silver are included in the tables during that time. The Rex mine at Herb Lake was the outstanding producer during this ten-year period, as it produced considerable quantities of gold in 1918, 1924 and 1925. Throughout, however, the non-metallics had each year produced much greater value than the metallics.

MINERAL PRODUCTION IN MANITOBA

1920 — 1937



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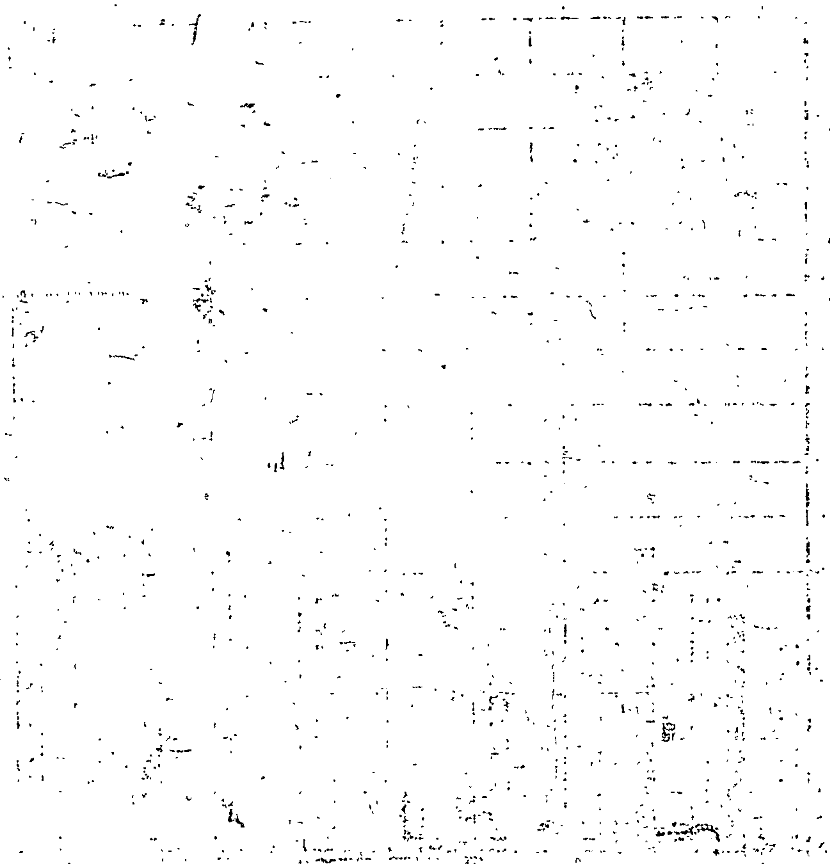

Copper, too, appeared for the first time in the lists of 1917, coming from the Mandy mine, but no copper was recovered after 1920 until the Flin Flon mine came into production in 1930, since which time it has taken a very prominent place in the output for the Dominion, Manitoba now being the third largest producer in Canada.

Even before the creation of the Department of Mines and Natural Resources in Manitoba in 1928, attention to mineral statistics was being given by the Industrial Development Board of Manitoba, particularly through the efforts of R.C.Wallace. In the many pamphlets having to do with the mining industry, issued by that Board, prominence was given to the value of the mineral production to the province. When the province took over the control of the natural resources from the Dominion on July 15, 1930, a working arrangement was made with the Dominion Bureau of Statistics whereby the Department of Mines and Natural Resources, Manitoba, through its Mines Branch became responsible for the collection of all statistics concerned with mineral production in the province.

The Mines Branch of Manitoba has, then, since 1931, the first full calendar year of its operation, been collecting the figures for the province, which are in turn sent to the Bureau of Statistics at Ottawa.

The production figures collected each year are based on the calendar year. The entry of metals to the production table has been as follows:

1917	-	Copper, gold and silver
1930	-	Zinc
1935	-	Lead, selenium and tellurium
1936	-	Cadmium

PRODUCTION FROM MINES IN MANITOBA

Production of metals in Manitoba commenced in 1916, following the discovery of the Mandy mine at Schist Lake, northern Manitoba.

CHAPTER 11

PRODUCTION FROM MINES OF MANITOBA

While Manitoba has been producing copper and gold since 1917, there was an interesting difference in the time that elapsed between the discovery of the deposit and the commencement of production.

Transportation difficulties did militate against the early discoveries but it is noteworthy that the Mandy property, located in October, 1915, was in actual production of ore in the fall of 1916. Here was an ore-body of massive chalcopyrite too small to warrant the building of a smelter but of a grade, about 20 per cent copper with additional values in gold and silver, that made its exploitation attractive. This, together with a war price of 26 cents a pound for copper, made its operation possible even in the face of transportation difficulties.

The Flin Flon property on the other hand, while it was located earlier than the Mandy, in 1915 presented greater difficulties to overcome. However, the tonnage blocked out in exploration work was large, and to the promoters appeared, after patient research, to warrant the expenditure of a large amount of money in the construction of extensive plants, even before any production could be obtained. As a consequence, it was not until November, 1930, that the Hudson Bay Mining and Smelting Company was able to begin production.

The area about the San Antonio was prospected for gold as early as 1911, yet it was not until 1932 that the mine went into production. The area about Rice Lake suffered many reverses in its earlier history. Transportation was, until the advent of the tractor and the improvement of the water-road route to Rice Lake, very expensive. The extent of ore occurrences was somewhat doubtful, particularly to the investing

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public of Manitoba, but those who took the risks are now being rewarded.

The Rex mine (now Laguna) at Herb Lake is another example of the dormant property recovering and improving under recent development. Removed some 22 miles from railway transportation, the mine is now amply served by road and lake service. Though located in 1914, the mine can be said to have come into successful operation in 1936.

Sherritt Gordon Mines, Limited, was able to take advantage of much experience gained in the north country and in the hands of aggressive operators, extensive developments had been done within four years after discoveries of copper ore were made near Cold (Kississing) Lake. And as an outcome of aggressive development, the company was able to begin production in 1930.

The record in Manitoba for bringing a mine into production rests with the God's Lake Gold Mines, Limited, where, in spite of a long tractor haul in winter, the company was shipping gold within three years after the discovery of the property.

Other recent producers in Manitoba - the Gunnar and the Gurney mines - have also made rapid progress into the production stage.

The attached table gives information as to the value of production of minerals in Manitoba since 1907.

MINERAL PRODUCTION IN MANITOBA
1935 - 1937

The mineral production for the years 1935-1937 is shown under the following main headings:

	1935	1936	1937
Metallics	$10,474,093	9,511,829	14,193,412
Non-metallics	1,578,324	1,803,698	1,767,669
Total -	$12,052,417	$11,315,527	$15,961,081

TOTAL VALUE OF MINERAL PRODUCTION OF MANITOBA, 1907 - 1937

Year	Metallic $	Non-Metallic $	Structural Materials $	Clay Products $	Total $
1907-1915*					14,378,103
1916-1929	3,291,145	5,974,879	28,199,943	2,648,909	40,114,876
1930	870,248	298,477	4,068,490	215,967	5,453,182
1931	7,209,993	311,725	2,433,071	122,628	10,077,417
1932	7,571,444	230,579	1,209,960	49,773	9,061,756
1933	8,242,695	117,397	646,046	20,966	9,027,104
1934	8,894,576	120,616	723,826	37,916	9,776,934
1935	10,474,093	118,710	1,384,859	74,755	12,052,417
1936	9,511,829	136,909	1,611,225	55,564	11,315,527
1937	14,193,412	141,161	1,530,267	96,241	15,961,081
Grand Total -	$ 70,259,435	7,450,453	41,807,687	3,322,719	137,218,397

* Prior to 1915 no classification was made of the mineral production. The figure of $14,378,103 has to be added to the classified totals to obtain the grand total.

The following are the amounts obtained by mines in Manitoba for exchange equalization on gold over and above the price of $20.671834, for the years 1931-1937:

1931	-	$ 90,613
1932	-	$ 343,906
1933	-	$ 993,478
1934	-	$ 1,829,757
1935	-	$ 2,070,479
1936	-	$ 1,999,705
1937	-	$ 2,297,036

MINERAL PRODUCTION OF MANITOBA, 1916 - 1937

(Figures supplied by Dominion Bureau of Statistics, Ottawa, to 1929)

Product	Unit	1916 Quantity	1916 Value	1917 Quantity	1917 Value	1918 Quantity	1918 Value	1919 Quantity	1919 Value	1920 Quantity	1920 Value
			$		$		$		$		$
Gold	Oz.	......	......	440	9,095	6,755	139,638	724	14,966	781	16,145
Exchange Equalization on Gold		......	......	......	......	......	......	......	......	......	......
Silver	Oz.	......	......	7,201	5,863	13,316	12,886	20,760	23,069	15,510	15,649
Copper	Lb.	......	......	1,116,000	303,329	2,339,751	576,234	3,348,000	625,775	3,062,577	534,604
Zinc	Lb.	......	......	......	......	......	......	......	......	......	......
Tellurium	Lb.	......	......	......	......	......	......	......	......	......	......
Cadmium	Lb.	......	......	......	......	......	......	......	......	......	......
Selenium	Lb.	......	......	......	......	......	......	......	......	......	......
Lead	Lb.	......	......	......	......	......	......	......	......	......	......
Tungsten Concen's	Lb.	......	......	......	......	177	42	......	......	......	......
Coal	Tons	......	......	......	......	......	......	......	......	......	......
Natural Gas	M. Cu. Ft.	......	......	......	......	......	......	......	......	200	60
Salt	Tons	......	......	......	......	......	......	......	......	......	......
Gypsum	Tons	28,489	191,283	33,347	258,934	37,483	341,352	32,903	371,337	44,371	487,894
Quartz	Tons	......	......	......	......	......	......	......	......	......	......
Feldspar	Tons	......	......	......	......	......	......	......	......	......	......
Sand-Lime Brick	No.	3,215,097	33,048	5,070,500	76,742	5,395,423	82,438	7,389,300	124,847	10,278,802	197,734
Cement	Brl.	427,293	794,897	544,949	1,175,669	500,302	1,283,948	......	......	......	......
Lime	Bus.	355,301	83,754	393,982	92,932	462,544	134,725	476,452	147,131	605,299	210,984
Stone	Tons	......	372,894	......	301,968	......	238,251	......	89,067	......	374,286
Sand and Gravel	Tons	......	......	......	......	......	......	......	......	......	......
Clay Products		......	104,248	......	114,651	......	116,417	......	131,737	......	206,764
*Other Products		......	243,452	......	289,081	......	294,493	......	1,340,449	......	2,179,341
Total		......	1,823,576	......	2,628,264	......	3,220,424	......	2,868,378	......	4,223,461

Product	Unit	1921 Quantity	1921 Value	1922 Quantity	1922 Value	1923 Quantity	1923 Value	1924 Quantity	1924 Value	1925 Quantity	1925 Value
			$		$		$		$		$
Gold	Oz.	207	4,279	156	3,225	31	641	1,180	24,393	† 4,689	†96,930
Exchange Equalization on Gold		......	......	......	......	......	......	......	......	......	......
Silver	Oz.	33	20	20	14	5	3	140	93	† 582	† 402
Copper	Lb.	......	......	......	......	......	......	......	......	......	......
Zinc	Lb.	......	......	......	......	......	......	......	......	......	......
Tellurium	Lb.	......	......	......	......	......	......	......	......	......	......
Cadmium	Lb.	......	......	......	......	......	......	......	......	......	......
Selenium	Lb.	......	......	......	......	......	......	......	......	......	......
Lead	Lb.	......	......	......	......	......	......	......	......	......	......
Tungsten Concen's	Lb.	......	......	......	......	......	......	......	......	......	......
Coal	Tons	......	......	......	......	......	......	......	......	......	......
Natural Gas	M. Cu. Ft.	200	60	200	60	200	60	200	60	200	60
Salt	Tons	......	......	......	......	......	......	......	......	......	......
Gypsum	Tons	40,859	480,282	34,072	440,914	31,575	386,554	29,375	348,212	35,088	417,868
Quartz	Tons	......	......	......	......	......	......	......	......	......	......
Feldspar	Tons	......	......	......	......	......	......	......	......	......	......
Sand-Lime Brick	No.	......	......	......	......	......	......	......	......	......	......
Cement	Brl.	......	......	......	......	......	......	286,948	746,750	407,395	1,037,929
Lime	Bus.	413,283	136,375	525,184	163,799	524,128	161,226	394,229	121,518	450,315	170,230
Stone	Tons	‡ 16,868	56,666	34,359	106,638	51,304	118,277	54,065	93,876	52,770	188,496
Sand and Gravel	Tons	......	......	......	......	......	......	359,535	81,897	727,152	196,601
Clay Products		......	208,982	......	210,740	......	160,134	......	117,450	......	173,794
*Other Products		......	*1,047,453	......	*1,333,552	......	*941,142	......	......	......	......
Total		......	1,934,117	......	2,258,942	......	1,768,037	......	1,534,249	......	2,282,310

Product	Unit	1926 Quantity	1926 Value	1927 Quantity	1927 Value	1928 Quantity	1928 Value	1929 Quantity	1929 Value	1930 Quantity	1930 Value
			$		$		$		$		$
Gold	Oz.	188	3,886	182	3,762	19,813	409,571	22,455	464,186	23,189	479,359
Exchange Equalization on Gold		......	......	......	......	......	......	......	......	......	......
Silver	Oz.	18	11	12	7	1,763	1,026	2,644	1,401	94,653	36,114
Copper	Lb.	......	......	......	......	......	......	......	......	2,087,609	216,018
Zinc	Lb.	......	......	......	......	......	......	......	......	3,882,141	139,757
Tellurium	Lb.	......	......	......	......	......	......	......	......	......	......
Cadmium	Lb.	......	......	......	......	......	......	......	......	......	......
Selenium	Lb.	......	......	......	......	......	......	......	......	......	......
Lead	Lb.	......	......	......	......	......	......	......	......	......	......
Tungsten Concen's	Lb.	......	......	......	......	......	......	......	......	......	......
Coal	Tons	......	......	......	......	......	......	......	......	......	......
Natural Gas	M. Cu. Ft.	200	60	200	60	200	60	600	180	600	180
Salt	Tons	......	......	......	......	......	......	......	......	......	......
Gypsum	Tons	35,172	461,461	39,895	512,008	51,285	609,039	67,269	631,051	34,167	298,297
Quartz	Tons	......	......	......	......	......	......	10,045	35,610	......	......
Feldspar	Tons	......	......	......	......	......	......	......	......	......	......
Sand-Lime Brick	No.	......	......	......	......	......	......	......	......	......	......
Cement	Brl.	612,155	1,572,401	551,698	1,378,121	693,450	1,685,084	1,000,258	2,350,606	977,906	2,268,742
Lime	Bus.	685,389	251,269	648,975	246,279	‡ 28,337	319,699	‡ 32,246	361,104	‡ 24,098	260,325
Stone	Tons	101,571	357,884	154,666	318,556	235,864	608,217	192,109	895,017	147,078	1,085,479
Sand and Gravel	Tons	989,581	178,059	1,333,580	228,655	1,653,929	262,006	1,782,085	322,430	1,253,103	453,944
Clay Products		......	248,497	......	201,464	......	291,791	......	362,240	......	215,967
*Other Products		......	......	......	......	1	° 360	......	......	......	......
Total		......	3,073,528	......	2,888,912	......	4,186,853	......	5,423,825	......	5,453,182

Product	Unit	1931 Quantity	1931 Value	1932 Quantity	1932 Value	1933 Quantity	1933 Value	1934 Quantity	1934 Value
			$		$		$		$
Gold	Oz.	102,969	2,128,558	122,507	2,532,444	125,310	2,590,388	132,321	2,735,318
Exchange Equalization on Gold		......	90,613	......	343,906	......	993,478	......	1,829,757
Silver	Oz.	836,547	249,877	1,036,497	328,275	1,101,578	416,758	1,252,920	694,647
Copper	Lb.	48,821,432	3,835,254	52,706,861	3,362,803	38,163,181	2,844,989	30,867,141	2,290,126
Zinc	Lb.	36,173,749	898,338	41,736,600	1,004,016	43,516,037	1,397,082	47,264,342	1,438,538
Tellurium	Lb.	......	......	......	......	......	......	......	......
Cadmium	Lb.	......	......	......	......	......	......	......	......
Selenium	Lb.	3,870	7,353	......	......	......	......	4,127	6,190
Lead	Lb.	......	......	......	......	......	......	......	......
Tungsten Concen's	Lb.	......	......	......	......	......	......	......	......
Coal	Tons	1,306	3,797	† 2,830	† 7,075	† 3,960	† 9,367	4,113	8,952
Natural Gas	M. Cu. Ft.	600	180	600	180	600	180	600	180
Salt	Tons	......	......	508	7,092	1,499	18,388	1,664	20,137
Gypsum	Tons	23,076	231,124	12,719	113,739	6,830	66,471	9,657	81,553
Quartz	Tons	67,214	76,624	87,253	102,493	7,736	23,507	931	3,031
Feldspar	Tons	......	......	......	......	88	484	1,793	6,763
Sand-Lime Brick	No.	......	......	......	......	......	......	......	......
Cement	Brl.	644,160	1,267,893	242,112	549,594	129,540	295,351	181,166	411,247
Lime	Bus.	‡ 21,014	207,401	‡ 18,235	172,110	‡ 18,032	167,640	‡ 16,568	163,608
Stone	Tons	153,356	642,649	78,423	299,282	33,190	74,227	43,127	53,545
Sand and Gravel	Tons	†1,041,016	† 316,128	440,309	188,974	† 288,214	108,828	334,026	95,426
Clay Products		......	122,628	......	49,773	......	20,966	......	37,916
*Other Products		......	......	......	......	......	......	......	......
Total		......	10,077,417	......	9,061,756	......	9,027,104	......	9,776,934

‡In Tons. *For 1921, 1922, 1923 includes Cement, Sand, Gravel. †Figures obtained in Manitoba. °Rose Quartz.

Mines Branch, Department of Mines and Natural Resources,
1-10-36. Winnipeg, Manitoba.

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MINERAL PRODUCTION OF MANITOBA, 1916 - 1937

(Figures supplied by Dominion Bureau of Statistics, Ottawa, to 1929)

1917 Quantity	1917 Value	1918 Quantity	1918 Value	1919 Quantity	1919 Value	1920 Quantity	1920 Value	1921 Quantity	1921 Value	1922 Quantity	1922 Value	1923 Quantity	1923 Value
	$		$		$		$		$		$		$
440	9,095	6,755	139,638	724	14,966	781	16,145	207	4,279	156	3,225	31	641
......	......	......	......	......	......	......	......	......	......	......	......	......	......
7,201	5,863	13,316	12,886	20,760	23,069	15,510	15,649	33	20	20	14	5	3
,116,000	303,329	2,339,751	576,234	3,348,000	625,775	3,062,577	534,604	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	177	42	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	200	60	200	60	200	60	200	60
......	......	......	......	......	......	......	......	......	......	......	......	......	......
33,347	258,934	37,483	341,352	32,903	371,337	44,371	487,894	40,859	480,282	34,072	440,914	31,575	386,554
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
070,500	76,742	5,395,423	82,438	7,389,300	124,847	10,278,802	197,734	......	......	......	......	......	......
544,949	1,175,669	500,302	1,283,948	......	......	......	......	......	......	......	......	......	......
393,982	92,932	462,544	134,725	476,452	147,131	605,299	210,984	413,283	136,375	525,184	163,799	524,128	161,226
......	301,968	......	238,251	......	89,067	......	374,286	‡ 16,868	56,666	34,359	106,638	51,304	118,277
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	114,651	......	116,417	......	131,737	......	206,764	......	208,982	......	210,740	......	160,134
......	289,081	......	294,493	......	1,340,449	......	2,179,341	......	1,047,453	......	1,333,552	......	*941,142
......	2,628,264	......	3,220,424	......	2,868,378	......	4,223,461	......	1,934,117	......	2,258,942	......	1,768,037

1924 Quantity	1924 Value	1925 Quantity	1925 Value	1926 Quantity	1926 Value	1927 Quantity	1927 Value	1928 Quantity	1928 Value	1929 Quantity	1929 Value	1930 Quantity	1930 Value
	$		$		$		$		$		$		$
1,180	24,393	† 4,689	196,930	188	3,886	182	3,762	19,813	409,571	22,455	464,186	23,189	479,359
......	......	......	......	......	......	......	......	......	......	......	......	......	......
140	93	† 582	† 402	18	11	12	7	1,763	1,026	2,644	1,401	94,653	36,114
......	......	......	......	......	......	......	......	......	......	......	......	2,087,609	215,018
......	......	......	......	......	......	......	......	......	......	......	......	3,882,141	139,757
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
200	60	200	60	200	60	200	60	200	60	600	180	600	180
......	......	......	......	......	......	......	......	......	......	......	......	......	......
29,375	348,212	35,088	417,868	35,172	461,461	39,895	612,008	51,285	609,039	67,269	631,051	34,157	298,297
......	......	......	......	......	......	......	......	......	......	10,045	36,610	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......	......	......	......	......
286,948	746,750	407,395	1,037,929	612,165	1,572,401	551,698	1,378,121	693,450	1,685,084	1,000,258	2,350,606	977,906	2,268,742
394,229	121,518	450,315	170,230	686,389	251,269	648,975	246,279	‡ 28,337	319,699	‡ 32,246	361,104	‡ 24,098	260,325
54,065	93,876	52,770	188,496	101,571	357,884	154,666	318,556	235,864	608,217	192,109	895,017	147,078	1,085,479
359,535	81,897	727,152	196,601	989,581	178,059	1,333,580	228,655	1,653,929	262,006	1,782,085	322,430	1,253,103	455,944
......	117,450	......	173,794	......	248,497	......	201,464	......	291,791	......	362,240	......	215,967
......	......	......	......	......	......	......	......	1	° 360	......	......	......	......
......	1,634,249	......	2,282,310	......	3,073,528	......	2,888,912	......	4,186,853	......	5,423,826	......	5,453,182

1931 Quantity	1931 Value	1932 Quantity	1932 Value	1933 Quantity	1933 Value	1934 Quantity	1934 Value	1935 Quantity	1935 Value	1936 Quantity	1936 Value	1937 Preliminary Quantity	1937 Preliminary Value
	$		$		$		$		$		$		$
102,969	2,128,568	122,507	2,532,444	125,310	2,590,388	132,321	2,736,318	142,613	2,948,072	139,273	2,879,028	160,428	3,316,341
......	94,613	......	343,906	......	993,478	......	1,829,757	......	2,070,479		1,999,705		2,297,036
836,547	249,877	1,036,497	328,275	1,101,678	416,758	1,252,920	694,647	1,206,454	781,660	791,489	357,175	985,221	442,178
45,821,432	3,835,254	52,706,861	3,362,803	38,163,181	2,844,989	30,867,141	2,290,126	38,011,371	2,963,146	29,853,220	2,829,190	45,952,000	6,009,603
35,173,749	898,338	41,736,600	1,004,016	43,616,037	1,397,082	47,264,342	1,438,638	51,129,980	1,584,613	36,744,931	1,218,095	36,200,000	1,774,524
......	......	......	......	......	......	......	......	340	680	3,928	6,955	5,100	8,823
......	......	......	......	......	......	......	......	......	......	148,133	131,838	164,000	268,960
3,870	7,353	......	......	......	......	4,127	6,190	65,074	124,942	50,760	89,845	43,900	75,947
......	......	......	......	......	......	......	......	19,179	601				
......	......	......	......	......	......	......	......	......	......				
1,306	3,797	† 2,830	† 7,075	† 3,960	† 9,367	4,113	8,962	3,106	7,408	4,029	9,525	3,180	7,727
600	180	600	180	600	180	600	180	600	180	600	180	600	180
......	......	508	7,092	1,499	18,388	1,664	20,137	1,538	18,765	2,498	32,151	3,391	43,465
23,076	231,124	12,719	113,739	6,830	65,471	9,667	81,563	10,500	85,885	12,064	87,076	13,941	88,095
67,214	76,624	87,263	102,493	7,736	23,507	931	3,031	147	220	90	45		
......	......	......	......	88	484	1,793	6,763	2,084	6,252	1,322	7,932		
......	......	......	......	......	......	......	......	......	......				
644,160	1,267,893	242,112	549,594	129,540	295,351	181,166	411,247	266,457	604,857	348,042	783,095	328,518	745,736
‡ 21,014	207,401	‡ 18,235	172,110	‡ 18,032	167,640	‡ 16,568	163,608	‡ 18,616	185,517	21,780	211,035	22,597	215,165
153,356	642,649	78,423	299,282	33,190	74,227	43,127	63,545	146,614	189,755	49,506	71,968	41,191	65,270
†1,041,016	† 315,128	440,309	188,974	† 288,214	108,828	334,026	95,426	1,399,659	404,730	1,852,606	545,130	1,763,333	504,096
......	122,628	......	49,773	......	20,966	......	37,916	......	74,755		55,564		96,241
......	......	......	......	......	......	......	......	......	......			Lithium 32	1,694
......	10,077,417	......	9,061,756	......	9,027,104	......	9,776,934	......	12,052,417		11,315,527		15,961,081

‡In Tons. *For 1921, 1922, 1923 includes Cement, Sand, Gravel. †Figures obtained in Manitoba. °Rose Quartz.

AREAL DISTRIBUTION - METAL AND NON-METAL

The division of the province into areas producing metals and non-metals is purely geographic and follows the geological boundary between the Pre-Cambrian shield and the overlying formations of Palaeozoic age.

CHAPTER 12.

AREAL DISTRIBUTION AS TO METAL AND NON-METAL

It is very difficult to place a distinction between the terms "metal " and "non-metal" as employed by the mineral industry. It is clear that such elements produced as copper, iron, gold, silver, zinc, etc., would fall within the range of metals. And it is equally apparent that such materials as coal, gas, oil, building-stone, clay, gravel, etc., would be classed as non-metals. That is the broad distinction implied in the present instance. There are, however, a group of minerals which yield metals whose use is not metallic in the usual interpretation of the word; to mention one, lithium, a metal similar to sodium and potassium. This metal occurs in deposits similar in origin to the other metals won from the rocks of Northern Manitoba, but its uses are almost entirely as a chemical in various phases of industry. It is, therefore, not the purpose of this report to draw a hard and fast line between what should be termed a metal or non-metal, but to differentiate only in the broadest sense of the terms.

With the exception of one or two special cases, the division of the province into the areas producing metals and non-metals is purely geographic and follows the geological boundary between the Pre-Cambrian shield and the overlying formations of Palaeozoic age. Pre-Cambrian rocks are exposed in the extreme southeastern corner of the province and outcrop mainly to the north of Winnipeg River. From the mouth of Winnipeg River, Pre-Cambrian rocks are exposed along the entire east shore of Lake Winnipeg with rocks of Palaeozoic

age outcropping along the west shore and also on many of the islands in the lake. From the extreme north end of the lake, the Pre-Cambrian-Palaeozoic rock contact follows a rather irregular course northerly to two miles north of Ponton siding on Hudson Bay Railway. From that point the contact follows a westerly course touching the south ends of Wekusko, Reed and Iswasum lakes, and thence westerly to the Saskatchewan-Manitoba boundary, passing midway through Lake Athapapuskow.

In the division of metallics which during the past decade has contributed the largest amount to the mineral wealth of the province, the following metals may be listed in decreasing order of value. These metals are mined exclusively from the mineral areas of the Pre-Cambrian from mines operating in widely separated areas. The metals are gold, copper, zinc, silver and cadmium. To these may be added two substances which, though not classified chemically as metals, are nevertheless won from metallic ores and are, therefore, grouped with the division of metallics. These two substances are selenium and tellurium and are recovered from the ore of Hudson Bay Mining and Smelting Co., Ltd., at Flin Flon during the electrolytic refining of the blister copper, at Montreal, Que.

In addition to the list of metals actually produced at the present time, many others are known to occur in Manitoba mineral deposits. Some of these metals will be utilized when the techno-logy of their extraction becomes economically established or industry finds sufficient application for their use as alloys. Such metals that await future development are beryllium, lithium, nickel, molyb-donum, arsenic, tungsten and possibly iron from large iron sulphide dykes occurring throughout the province. Such metals as bismuth,

[illegible]

antimony, lead, mercury, cobalt are not known to exist other than in occasional samples or as associates with other metals in amounts that make their utilization non-economic.

All of the metals dealt with so far have been either worked or encountered in the area designated as the Pre-Cambrian shield. Based on sound geologic principles, the assumption may be correctly made that the chances of discovery of any of the foregoing metals in Manitoba will be confined entirely to areas underlain by Pre-Cambrian rocks.

In the southwestern section of the province, the bulk of the non-metallic materials are obtained. Deposits of coal have been worked intermittently since the beginning of the century in an area south of the town of Deloraine. Small seepages of gas are known, and in the vicinity of Waskada and Treherne, gas has been used in some homes for domestic purposes. The flow is small.

At Gypsumville and at Amaranth, important deposits of gypsum are worked. Limestones, meeting all requirements of the building industry, are found within the boundaries of the province. Tyndall limestone, by far the most desirable type of dimension stone to be found in western and possibly all Canada, occurs some thirty miles east of Winnipeg. There is a very large variety of granite available to the railways which pass through Pre-Cambrian country in eastern and northern Manitoba, and to Lake Winnipeg.

Clays suitable for the manufacture of brick, Portland and natural cement are found at various points in the southwestern section of Manitoba. Road metal is abundant in almost all parts of the province, being obtained chiefly from glacial deposits in the form of coarse gravel.

Thus, it may be seen that in a broad sense, the geographic division between the areas producing metallic and non-metallic mineral wealth follows the geological boundary of the Pre-Cambrian shield. Clays, deposits of gravel, and peat bogs occur in abundance, however, in the shield areas and may be utilized as settlement dependent upon mineral development becomes established to an increasing degree.

The information given on each of the mineral materials is necessarily given only in summary, but on the other hand it shows the great variety of mineral deposits -- metallic and non-metallic -- in the province.

METALLIFEROUS DEPOSITS

ANTIMONY

Stibnite, the sulphide of antimony, is found in galena-sphalerite replacement deposits on Little Herb River and in quartz veins on the east side of Herb Lake. Veins carrying masses of solid stibnite associated with quartz and calcite occur in sericite schist near the west end of Oxford Lake. Grey copper ore has been reported from at least one locality, near English Brook, north of Wanipigow (Hole) River and it may be that part of it consists of tetrhedrite, the antimony-bearing variety.

The discovery on Oxford Lake is of some interest, since it suggests the possibility of the occurrence of antimony in commercial quantity. Several hundred pounds of pure stibnite were cobbed from the ore during surface development. However, it is improbable that antimony will figure largely in Manitoba's future mineral production. Commercial deposits of antimony ore are typically of a shallow type and most of Manitoba's deposits are of deep origin.

ARSENIC

Arsenopyrite (mispickel) is widely distributed in association with gold quartz veins in the Wekusko (Herb) Lake district in northern Manitoba. In places the wall rock for a width of a few inches up to a foot is almost solid arsenopyrite. Part of the gold values is carried in fine-grained arsenopyrite. Arsenic could be recovered from the ore. Arsenopyrite is found also in considerable quantity in the Star Lake - Falcon Lake area in eastern Manitoba in similar association, as well as at Wallace and Tartan Lakes.

BERYL

Beryl, a mineral containing beryllium, occurs in pegmatites mainly in the same localities and even in the same deposits as the lithium minerals.

In the lithium-bearing bodies, beryl is most abundantly present in the Bernic Lake deposits, but also occurs in the Cat Lake deposits, on the Bear, Annie and Gray mineral claims, and on the Captain group of claims. (See Lithium). It also occurs in the Herb Lake area.

Beryl has been noted in eleven non-lithium bodies. Three of these occur at Cat Lake and consist chiefly of albite aplite, in which are patches of quartz-muscovite rock. Other occurrences are on the Captain claims in a dyke 2 miles southwest of this group; two microcline pegmatites in the northeast and northwest corners of section 1, township 15, range 16, east of the Principal meridian.

The outstanding discovery of beryl in the region is in a pegmatite dyke on the Huron claim which is about ½ mile inland

from a point on the southeast shore of Winnipeg River, 9 to 10 miles above Pointe du Bois in the vicinity of the lithium dyke on the Bear claim. The zone carrying beryl on this claim is about 20 feet wide, and the richer portions with more massive beryl are 8 feet wide.

Other deposits of beryl occur at Shatford Lake, at several places near Bernic Lake and at other localities. Regarding the economic possibilities of the deposits in Manitoba, DeLury says,

> "A great deal must be done still to prove that large tonnages of beryl can be shipped from Manitoba, but there is one deposit at least and perhaps several more to be proved and found, that give high hopes that the Province may be a producer when the time arrives for a large consumption of the metal beryllium."

BISMUTH

Bismuth occurs in pegmatitic quartz veins as the native metal and in the form of bismuthinite, the sulphide, in the vicinity of Star Lake in southeastern Manitoba, where it is commonly associated with molybdenite. The metal has also been noted in lithium-bearing pegmatite dykes near Cat Lake, north of Oiseau (Bird) River. Tetradymite, a bismuth telluride, occurs also in the English Brook area north of Wanipigow (Hole) river.

CADMIUM

Cadmium is obtained in the refining of the zinc sulphide concentrate at Flin Flon, it being associated with the sphalerite or zinc blende in the ore. The cadmium is recovered as a precipitate in the zinc plant residues. In 1937 164,000 pounds of the metal were recovered.

COBALT

Cobalt bloom has excited some interest in a few localities, due to the fact that its occurrence suggests the possibility of silver. No deposits of the cobalt-silver type have, however, been discovered. The typical occurrence of cobalt in Manitoba is as finely disseminated cobaltite or smaltite in metamorphic rocks. These minerals oxidize to give the well known bloom, known as erythrite. Occurrences of the kind described have been reported from the northeast arm of Schist Lake in northern Manitoba, and from the Falcon Lake area of the southeastern part of the province, as well as from other localities.

COPPER

Copper is a widely distributed metal in the province. The chief occurrences are associated with pyrite and sphalerite and carry values in gold and silver. These are represented by the Mandy, Flin Flon and Sherritt-Gordon deposits in northern Manitoba. Next in importance is a type in which chalcopyrite occurs with pyrrhotite in massive sulphide bodies carrying values in nickel and in the platinum group of metals. Such ore-bodies occur, associated with gabbro, in the vicinity of Maskwa (Bear) and Oiseau (Bird) Rivers in southern Manitoba. Chalcopyrite is also a common ore-mineral in many gold-quartz veins.

Copper prospects occur in other parts of the province, notably near Athapapuskow, Cross, Oxford, Cranberry and Wekusko lakes. Copper minerals, other than chalcopyrite, are rare. Secondary copper minerals, such as native copper, the carbonates, covellite and chalcocite are developed near the surfaces of some ore-bodies. Bornite occurs in a few localities. Gray copper ore

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

is reported from the English Brook area, north of Wanipigow River.

Flin Flon Mine --- Interest was first aroused in the prospecting for copper in Manitoba when the large ore-body of mixed sulphides at Flin Flon lake -- staked in 1915 on a weathered gossan which panned values in gold -- was found to be primarily a copper sulphide deposit. The Flin Flon ore-body remains the largest copper deposit yet found in Manitoba. It is a fairly regularly shaped lens tapering gradually to the northwest and ending rather bluntly to the southeast. It strikes 30 degrees northwest and dips 60 to 70 degrees northeast. The boring records show that it plunges at a low angle to the south. The total length of the ore-body on the surface is 2,593 feet, and its greatest width near the surface, with some inclusions of greenstone, is 400 feet.

In eight years' operating, developments at the Flin Flon mine have reached a depth of 2,210 feet. During this time the mine has yielded some 10,804,000 tons of ore and at the end of 1935 showed ore reserves of 24,770,000 tons, an increase of 6,770,000 tons over the estimates of 1929. The reported values of the ore are: copper 2.10 per cent, zinc 3.86 per cent, gold .08 ounces and silver 1.28 ounces.

The minerals in order of abundance are: pyrite, sphalerite and chalcopyrite. Gold and silver occur, apparently associated with the pyrite. Cadmium, selenium, tellurium and cobalt also occur but in lesser amounts. The ore comprises two types, the one a solid sulphide, and the other a disseminated sulphide, with the former assaying higher in zinc and gold but lower in copper than the latter.

Mandy Mine --- The Mandy was the first deposit in northern Manitoba to undergo development. It was optioned soon after discovery and was diamond drilled in the summer of 1916. Incidentally, this was the first diamond drilling done in northern Manitoba and revealed an ore-body containing 25,000 tons of massive chalcopyrite averaging about 20 per cent copper and containing gold and silver to the value of about $5.00 per ton, together with an additional 180,000 tons of lower grade ore containing 5 to 8 per cent copper, 20 to 30 per cent zinc and gold, and silver to the value of $5.00 per ton.

During the period of 1917 to 1920 inclusive, there was mined and shipped about 25,000 tons of ore, which produced 9,866,328 pounds of copper valued at $2,039,943, with additional values of $5.00 per ton in gold and silver.

The property was dormant until 1928 when development operations were resumed. The shaft was deepened to 1,025 feet with levels below the old workings from 325 feet down. Operations were suspended late in 1929 to await better prices for copper.

The Mandy deposit as mined was 225 feet long and had a maximum width of 40 feet. It dips from 75 to 80 degrees to the east and pitches at a high angle to the south. The chief minerals were pyrite, the most abundant, with sphalerite and chalcopyrite in important quantities, and minor amounts of galena and arsenopyrite.

Sherritt-Gordon Mine - The property now known as the Sherritt-Gordon mine was discovered as early as 1922. It was restaked again in 1924, and after being optioned to several interests was finally taken up by Sherritt Gordon Mines Limited in 1927.

The ore-bodies occur in a well-defined shear zone in thin-bedded quartzite gneiss along the contact with a band of very basic

garnetiferous gneiss. The ore-bodies strike northwest and have an average dip of from 45 to 50 degrees. They occur as two elongated lenticular bodies, the east ore-body having a length of 4,200 feet and an average width of 15.2 feet, and the west ore-body, having a length of 5,800 feet and an average width of 15.5 feet. The ore is rather coarse-grained mixture of pyrrhotite, pyrite, chalcopyrite and sphalerite, with numerous rock inclusions ranging in size from grains the size of a pea, to blocks weighing several tons.

When the railway (Manitoba Northern Railway, Cranberry Portage to Sherridon) was completed in 1929, mining and milling machinery and construction material for the various plants were freighted in and plant construction and mine development were pushed to prepare the property for production at a rate of 1,800 tons daily. Later, when the plants were nearing completion, it was decided, owing to the drastic decline in copper prices, to operate only one of the three grinding and milling units and the mine was brought into production at this reduced capacity in March, 1931.

In June, 1932, after operating continuously for over a year, the mine was closed down and all operations suspended owing to further unprecedented declines in the price of copper. During its period of operation the mine produced 373,311 tons of ore from which were obtained 6,756 ounces of gold, 209,408 ounces of silver, and 24,647,569 pounds of copper.

With improvements in copper prices, the mine resumed production in August 1937, milling 1,500 tons of ore, the concentrate from which was shipped ~~to the~~ Hudson Bay Mining and Smelting Company smelter at Flin Flon. For five months' operation in 1937, the company mined 195,695 tons of ore, from which there was obtained:

Copper	-	9,951,718	pounds
Gold	-	2,534	"
Silver	-	80,672	"

In its report for the year ending 1937, the company shows ore reserves as follows:

3,755,000 tons - Copper 2.68 per cent; zinc 3.12 per cent; gold and silver 64 cents.

910,000 tons - Copper 1.20 per cent; gold and silver 60 cents.

The mine is served by three shafts referred to as East, Central and Main. The Main shaft is sunk on an incline of 51 degrees to a depth of 1,127 feet on the incline.

General - Manitoba's copper production now amounts to 11 per cent of the total copper metal produced in Canada.

In 1936 a further interesting discovery of copper ore was made 31 miles southeast of the Sherritt Gordon mine at the Dick-stone property, located between Morton and North Star Lakes. The copper in this ore is reported to average 4 per cent, with no zinc or values in precious metals.

GARNET

Beautifully developed garnets in sizes up to 3 inches in diameter occur at the east end of Anderson Lake, west of the Herb Lake area, associated with staurolite and reddish cyanite. A considerable proportion of the crystals are of museum quality. Heavy bands of garnet rock are found south of the Winnipeg River, ten miles northeast of Pointe du Bois, in altered sediments. These bands occur in quantity sufficient to justify investigations from the standpoint of an abrasive material.

GOLD

While isolated occurrences were known at an earlier date, the first systematic search for gold in Manitoba began in 1907 in the area north of The Pas, now usually known as The Pas mineral belt, culminating in discoveries in (Wekusko) Herb Lake in 1914 (the Kiski-Wekusko group). Discoveries were made in Rice Lake, east of Lake Winnipeg about 1911 (the Gabrielle property), and in the Star Lake country, west of the Lake of the Woods area, somewhat earlier (the Penniac property). Since 1910 prospecting has been carried on fairly continuously in the areas of which the initial discoveries were the centres of activity, until today the areas have extended to embrace (I) the belt from Athapapuskow Lake eastwards to Wintering Lake and northwards to Kississing (Cold) Lake; (II) the belt of the Wanipigow (Hole) and Manigotagan (Bad Throat) Rivers eastwards to the Ontario Boundary; (III) The West Hawk Lake - Star Lake - Falcon Lake area between the Canadian Pacific Railway and the Greater Winnipeg Water District Railway immediately west of the boundary line. In these areas activity has centred mainly in (I) Wekusko (Herb) Lake, Little Herb Lake, Elbow Lake and Copper Lake; (II) Rice Lake, Gold Lake, Long Lake, Bulldog Lake, Garner Lake, Gem Lake, Moore Lake, Hay Lake and the Luleo district; (III) Star Lake and Falcon Lake. Some prospecting has been done in the areas of Cross Lake, Pipestone Lake and Oxford Lake. In recent years God's Lake, Island Lake and Cranville Lake have been the scene of considerable activity.

The first recorded production of gold in Manitoba was that for 1917 when 28.5 tons of gold quartz ore were shipped from the

Moosehorn claim at Herb Lake to the smelter at Trail, B. C. The returns amounted to $2,323 or an average of more than $81 to the ton.

Following early discoveries gold was milled at the Luleo property (Wanipigow River), Gold Pan property (Gold Lake), Penniac property (Star Lake) and the Webb property (Elbow Lake).

The following mines are producing gold quartz ores:

San Antonio	-	Rice Lake
Gunnar	-	Beresford Lake
Oro Grande	-	Beresford Lake
God's Lake	-	God's Lake
Laguna (formerly the Rex)	-	Herb Lake
Gurney	-	between Copper and Brunne Lakes

The Flin Flon and Sherritt Gordon Mines, while primarily base metal producers, make the largest contribution to gold production of the province.

<u>San Antonio Mines</u> — The San Antonio Mines, located on the north shore of Rice Lake, holds the honour of being Manitoba's first dividend-payer. Its history goes back to 1911 when gold was discovered at Rice Lake, but it was not until 21 years later on May 1, 1932, that the San Antonio mine went into production. Milling capacity has since that time been increased from 110 to 320 tons a day. The company paid its first dividend, 5 cents a share, on March 15, 1934.

The ore occurrences at San Antonio are confined to a band of altered basic igneous rock, referred to as greenstone, which strikes northwesterly and dips at about 46 degrees to the northeast. The greenstone is of variable width and appears to have its greatest width towards the eastern end of the property, being divided at the west end of Rice Lake by a wedge-shaped mass of quartzose sediments.

The ore is of simple character. It consists essentially of quartz and pyrite. The gold is free but characteristically associated with the pyrite. Best gold values are generally associated with bands or blotches of fine to very fine pyrites, although this texture is not essential for values. Certain sections of ore will contain appreciable amounts of fairly coarse free gold in addition to the pyrite, but this is not typical of the ore as a whole. Chalcopyrite and sphalerite have been noted in the ore, but are of rare occurrence. Metallurgical tests have shown the ore to be amenable to all standard methods of treatment, upwards of 80.5 per cent extraction having been obtained by amalgamation alone.

Earlier in the mine's history, the most productive veins were Nos. 16 and 26, the former with a strike north of 60 degrees east and dipping 45 degrees to the northwest above the 300-foot level and from 60 to 70 degrees below that horizon; the latter strikes approximately north 35 degrees west and, for the most part, its dip is irregularly vertical.

Later additions to the ore reserves are Nos. 36 and 38 veins and the No. 3 vein on the Gabrielle property. Vein structure has been proved to a depth of 1500 feet.

The mine is served by two shafts Nos. 2 and 3 (Main), the former to a depth of 620 feet and the latter to 1050 feet. Deeper horizons are for the present reached through a winze north of the main shaft. For the year ending December 31, 1937, the company reports ore reserves of 256,516 tons.

In 1937, the company mined 115,765 tons of ore which produced gold to the value of $1,052,574. The total production since the start of milling operations to the end of 1937 was $4,940,560.

Gunnar Mine -- A noteworthy example of what may be done by prospecting old workings is that of the Gunnar property. This mine, now a producer and a dividend-payer, has its ore occurrences adjacent to and along old surface workings which, had they been prospected more thoroughly, would have yielded a mine at least five years sooner.

Following developments in 1935, the company prepared to build a cyanide plant. This was completed and put in operation April 17, 1936. Since that time milling has been carried on at a rate of 140 tons a day.

The ore shoots at the Gunnar mine occur in shear zones in volcanic rocks. The veins are variable in width and consist of a mixture of blue and white quartz with considerable amounts of carbonate. High values in gold occur in well-defined zones in the main veins and these appear to be associated with streaks of dark sphalerite. Free gold, pyrite, sphalerite and chalcopyrite appear to be associated with a light-coloured introduction of vein quartz. Most of the gold may be termed "free-milling".

The mine is served by two shafts, Nos. 1 and 2. The former, the main shaft, is sunk to a depth of 1250 feet, and the latter to 350 feet. For the year ending December 31, 1937, the company reports ore reserves of 79,092 tons.

In 1937, the mill treated 49,841 tons of ore from which gold to the value of $586,357 was produced. From the start of operations to the end of 1937, 82,031 tons have been treated, producing $965,028 in gold.

God's Lake Mine --

God's Lake Gold Mines, Ltd., organized in 1933, was the first company to undertake active development in the God's Lake

GOD'S LAKE GOLD MINES LTD. GODS LAKE

ROYAL CANADIAN AIR FORCE PHOTOGRAPH

area of northern Manitoba. Trenching and diamond drilling at the Akers group of mineral claims on Elk island showed up important values in gold and subsequent developments proved sufficient ore to warrant construction of a 150-ton mill. A power-plant of 1900-horsepower capacity was completed at Kanuchuan Rapids, some 40 miles southwest of God's Lake settlement. Milling began within three years of the initial discovery at God's Lake.

All the present known ore-bodies of the property are located in the tuff bed that occurs on the north contact of a dyke of augite diorite. Values are only found where the tuff bed is wide and usually in the centre of the bed.

The ore as a whole does not average 25 per cent quartz. Most of the sulphides and the gold occur in the quartz, but the tuff fragments and bands contain disseminated sulphides. Pyrrhotite is the predominant sulphide but with it is a considerable amount of pyrite and a little chalcopyrite and sphalerite. Galena and arsenopyrite are present but rarely. Free gold is conspicuous in places.

The mine is served by a Main Shaft to a depth of 950 feet. At December 31, 1937, the company reported ore reserves of 152,400 tons.

The company has operated its cyanide plant since the fall of 1935 and is now milling at a rate of 200 tons a day. For the year 1937, 61,477 tons of ore were milled and gold to the value of $626,640 was produced. From the inception of operations, the company has milled 130,993 tons of ore, valued at $1,399,622.

<u>Laguna Mine</u> - The Laguna property at Herb Lake was formerly known as the Rex, the claim which formed the property having been

staked in 1914. In 1918 the mine produced 1,337 ounces of gold and smaller amounts until 1924 and 1925 when gold was again produced. The mine was inactive from November, 1925, until the fall of 1934 when interest in the Herb Lake area was renewed.

The ore-body consists of a sugary-textured quartz vein that is locally well mineralized with arsenopyrite, pyrrhotite and gold, with sparing amounts of chalcopyrite and galena. Most of the gold values appear to be associated with the arsenopyrite mineralization. The vein strikes north 35 degrees and dips 70 to 75 degrees southeast. The width of the vein in places is 6 feet but the average is 2½ feet.

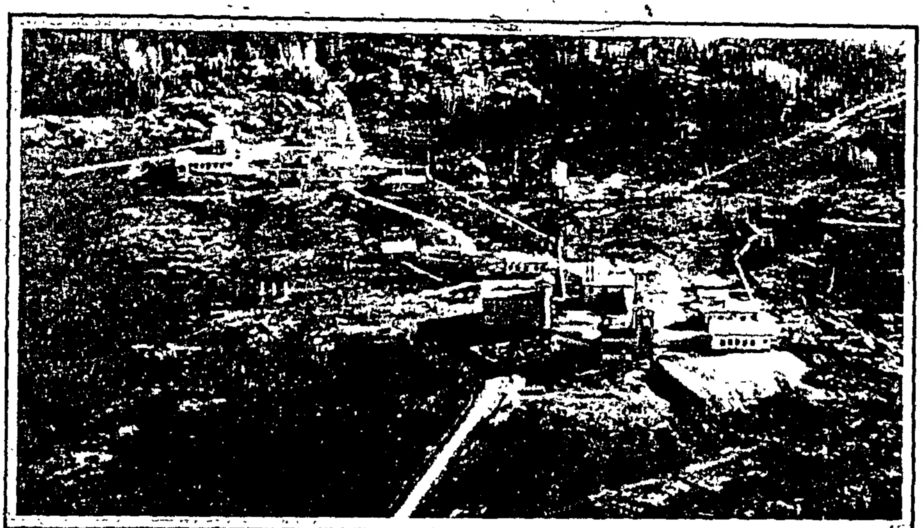
The mine resumed operations in 1935 and by August, 1936, went into production, milling at a rate of 50 tons a day. This has since been increased and milling is now being done at 90 tons a day. In 1937 the Laguna Gold Mines, Limited, mined 29,642 tons of ore from which gold to the value of $519,411 was produced.

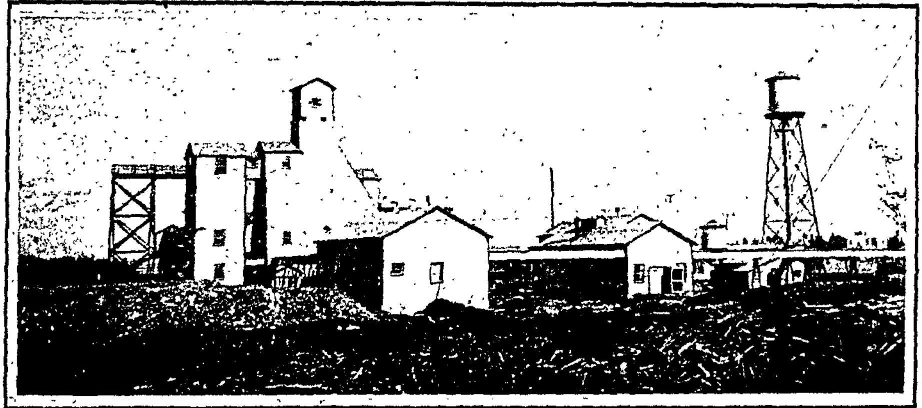
Since resumption of operations in 1936, there was 38,656 tons of ore mined and gold to the value of $684,347 produced.

The mine is served by a main shaft to a depth of 1,250 feet. At December 31, 1937, the company reported ore reserves of 29,727 tons.

Gurney Mine -- Gurney Gold Mines, Limited, took over the property of Wylie Dominion Mines, Limited, in 1935 and proceeded to carry on development on the Dominion Group of claims, staked in 1919, northeast of Brunne Lake.

The gold values at this property occur in a sheared tuff-like band in volcanic rocks. The mineralization consists of abundant pyrite, some galena, chalcopyrite and gold. The vein is





GURNEY GOLD MINES, LTD.

GUNNAR GOLD MINES, LTD.

irregular in width but strikes north 42 degrees east and dips 75 degrees to the northwest.

In 1937 the company decided to build a cyanide plant and at October 10th this was in operation with a capacity of 125 tons a day.

The mine is served by a Main shaft sunk to a depth of 650 feet.

For the period of a little better than two months, 9,800 tons of ore were mined and gold to the value of $60,200 produced.

Oro Grande Mine -- The Oro Grande property to the west side of Beresford lake was staked in 1919. Diamond drilling was done in 1925. In 1928 development was undertaken by Oro Grande Mines, Limited.

Where exposed or developed, the Oro Grande - Solo vein shows a width varying from a few inches up to six feet. The mineralization in the lenses of bluish white sugary quartz consists of pyrite, pyrrhotite and free gold. Much of the gold is visible. The quartz lenses vary greatly in thickness from widths of four feet to narrow silicified zones of schist mineralized with abundant sulphides.

The mine is served by two shafts -- the Solo (vertical) to a depth of 500 feet and the Oro Grande to a depth of 255 feet on an incline 62 degrees to the east. At the end of 1937, the mine was being operated on a lease basis by J. D. Shannon, milling some 35 tons a day.

IRON

Iron ore has not been produced so far in Manitoba's history. "Iron-Formation", the typical sedimentary series that has yielded so heavily in the Pre-Cambrian rocks around Lake Superior, is known to occur as remnants in the belts of schist in the province. In all cases, however, the "iron-formation" is still protore, that is, it lacks the weathering necessary to produce the enrichment for ore. Glaciation seems to have removed any enriched portions that may have existed before the Ice Age.

Other types of iron deposits are known to occur and it is to these that the province must look for a prospective iron industry. Magmatic segregations, contact-metamorphic deposits and veins of the deep zone [illegible] are of commercial importance in other parts of the world but they are all possible in the Pre-Cambrian formations of the province.

A deposit of hydrated iron oxide (turgite) occurs on the southeast shore of Black Island, Lake Winnipeg. A band of sericite schist contains lenses and disseminations of pisolitic turgite, associated with siderite. A little exploratory work was done on the deposit at different times between 1883 and 1902, but it is not easily accessible for investigation. No definite results were obtained except to indicate a low-grade deposit of unknown extent.

Magnetite occurs a short distance north of Falcon Lake, in southeastern Manitoba, as narrow high-grade veins, probably of deep-vein origin. Iron sand or magnetite is found in many areas and in some cases magnetic disturbances are probably traceable to magnetite in the drift. The occurrence of this type was recorded from Knee Lake as early as 1912.

Iron ochre, both limonite and hematite, is found in beds in the Palaeozoic limestone in the basins of the large lakes of southern Manitoba. A fairly large bed has been found north of Moose Lake.

LEAD

There has been one recorded production of lead in Manitoba - that from the Island Lake mine in 1935. It is not likely that it will ever assume an important place in the province's production of metals. If it is ever produced, it will likely be in a small quantity as a by-product from complex ores of other metals. Galena, lead sulphide, is fairly common in veins and replacement deposits of the other metals. A galena-sphalerite deposit on Little Hert Lake has a fairly heavy concentration of lead, with silver values. The deposit also carries antimony. It has given some promise of commercial interest but its importance has not yet been established.

LITHIUM

The discovery of a deposit of lithium minerals on the Bear mineral claim in 1924 attracted attention to the Winnipeg River area as a possible source of lithium. During the following two years other deposits were discovered at Bernic and Cat Lakes to the north, and Winnipeg River.

The following are the lithium-bearing locations at which work has been done:

The Bear mineral claim, 3 miles south of east from Lamprey Falls on Winnipeg River. This deposit was taken over by the Silver Leaf Mining Syndicate (Canada) Limited, and considerable development work was done. Small shipments were made to various

countries, including United States, England and Germany.

The Annie mineral claim and Gray mineral claim, three eighths of a mile northeast and one-quarter of a mile northwest respectively, of the dyke on the Bear claim.

The Captain group of claims in the southern portion of section 14, township 16, range 16, east of the Principal meridian, 3 miles slightly south of east of the dyke on the Bear mineral claim.

Near the east end of Bernic Lake nine lithium-bearing dykes occur over an area 500 feet wide and 3,000 feet long.

Five dykes occur at Cat Lake in the central part of township 19, range 15, east of the Principal meridian, 12 miles north of Bernic Lake deposits.

In the pegmatite, lithium minerals, including spodumene, lepidolite, zinnwaldite and a variety of other lithium-bearing micas, are present in large or small amounts.

Several pegmatite dykes are reported to occur in the Herb Lake area, bearing considerable quantities of lithium minerals, principally spodumene, although lepidolite, amblygonite and triphylite have been reported. Masses of beryl have been taken from some of these dykes.

A notable occurrence of the lithium mineral, spodumene was also discovered near Crowduck Bay in 1931.

In the Boundary area, near West Hawk Lake, several pegmatites are known to contain a concentration of lithium-bearing minerals, chiefly spodumene.

MOLYBDENUM

Molybdenite (molybdenum sulphide) occurs in beautifully large crystal aggregates associated with pegmatite carrying scheelite in the Falcon Lake district, south of Ingolf. As with the scheelite, some of the molybdenite was cobbed for shipment in 1918, but the drop of prices at the close of the war made further shipment impossible. Some molybdenite was also taken out from a pegmatite on the west shore of Crowduck Bay, Wekusko Lake. It occurs in noticeable quantity in Phantom Lake, in the Flin Flon district, and in many quartz veins in the gold areas in Manitoba. With it is usually found yellow encrustations of molybdenum ochre.

NICKEL

Manitoba has had no production of nickel though the metal is known to occur in promising prospects in the vicinity of Oiseau (Bird) and Maskwa (Bear) Rivers. Here, it is associated with copper and members of the platinum group of metals in a group of minerals very similar to the association found in the famous nickel-copper mines of the Sudbury district, Ontario. Some of these Manitoba occurrences were investigated a few years ago by diamond-drilling and surface trenching. After a quiet spell, interest revived and further investigation is now being pursued. The deposits appear to be genetically related to gabbro intrusions which are fairly widely distributed over a considerable area.

SELENIUM

Selenium is recovered in the refining of copper matte from Flin Flon ores.

[illegible]

[illegible]

[illegible]

SILVER

The silver production of Manitoba has so far been derived from mines primarily producing other metals.

The base metal ore-bodies at Flin Flon and Sherridon, and the various gold camps all contribute to the provincial output of this metal.

Native silver or highly argentiferous galena bodies of economic size are as yet unknown.

TIN

There has been no production of tin, but some occurrences of the metal are worthy of notice. Tin was first reported from the West Hawk Lake area, where it occurs in large replacement bodies of iron sulphides. The tin occurs in combination as a sulphide combined with copper and iron. Later on, cassiterite, the oxide of tin, was found in a pegmatite dyke on an island in Shatford Lake between Winnipeg and Oiseau (Bird) Rivers. In recent years further prospecting has brought to light numerous other occurrences. The district near Winnipeg and Bird Rivers is now being thoroughly investigated for its tin resources.

TUNGSTEN

Scheelite (lime tungstate) is found in quantities which, during war-time prices, were of economic grade, associated with pegmatites in the Falcon Lake area south of Ingolf. Several tons were quarried, cobbed and sacked for shipment in 1918, but with the conclusion of hostilities the price dropped and the scheelite

was not marketed. Associated with the scheelite is considerable molybdenite. Scheelite is also found in gold-bearing pegmatites on the west side of the north arm of Little Herb Lake, but in smaller quantity than at Falcon Lake. Wolframite and huebnerite have not been recorded in Manitoba.

ZINC

Zinc appeared in the list of Manitoba metals in 1930 when the Flin Flon mine commenced production of its copper-zinc ore. The zinc content in this ore is some 3.45 per cent. Since 1930, Hudson Bay Mining and Smelting Company, Limited, owners of the Flin Flon mine, have produced from 35,000,000 to 55,000,000 pounds of zinc annually, making Manitoba, with 17 per cent, the second largest zinc producer in the Dominion.

Zinc also occurs in the Mandy and Sherritt Gordon ores. In the massive chalcopyrite shipped from the Mandy mine between 1916 and 1920, the zinc content was negligible, but there was during that time 180,000 tons of lower grade left, consisting of mixed copper, iron and zinc sulphides, assaying 5 to 8 per cent copper, 20 to 30 per cent zinc, with gold and silver to the value of $5.00 per ton.

At Sherritt Gordon no attempt has yet been made to ship zinc concentrate. Zinc sulphide is, however, prominent in the ore, particularly in the east zone of the deposit. In general the higher-grade ore reserves of the mine show a zinc content of 3.12 per cent.

[illegible]

[illegible]

NON-METALLIFEROUS DEPOSITS

Though in an early stage of exploration, Manitoba already shows a considerable production of non-metallic minerals. Those that have so far been of economic importance are mentioned in the pages on mineral production. A number of others, as with the metallic mineral resources, are briefly described, particularly in those cases in which there are possibilities of production from known occurrences.

AMBER

A very interesting occurrence of a hydrocarbon of the amber family is that on the shore of a shallow bay of Cedar Lake immediately south of the Hudson's Bay Company post (Chemahawin) on that lake. This substance is amber coloured, less transparent than a typical amber, and was found by Harrington to differ somewhat in chemical composition from a true amber, and was named by him Chemawinite after the Hudson's Bay Company post. Lumps as large as a hen's egg have been found, but the pieces are on an average smaller than a pea. They occur on the beach of the lake, and under the water, mixed with sand and mud and decaying vegetable material. Even when selected, they are not of any value for ornamental purposes, though used by some of the older Hudson's Bay Company families in Winnipeg more from the local interest of the material than its artistic value. The material is, however, of value in the paint and varnish industry. It is in small percentage in the dirt, and an effective means of separation, capable of handling large quantities of the material at small cost, would be necessary. Chemawinite has also been found in some of

the [illegible] on the south end of [illegible] Lake. It is a fossil resin, from [illegible] of the Cretaceous age.

BENTONITE

A bentonitic material outcrops at several places in a ravine some four miles south of Morden, about equidistant between the Canadian Pacific and Canadian National Railways. Although known for several years, this material was first mined in [illegible]. [illegible] of [illegible] were shipped to be used principally in a [illegible] or a bond for [illegible] moulding sand. In [illegible], [illegible] tons were mined from sections 28 and 22, tp. 3, rge. 6, W.P.M.

Small shipments have been made from two other outcrops in the district.

This deposit covers a very large area, but examination has been confined chiefly to an area of about 1,000 acres. The bed is horizontal and appears to be remarkably uniform in thickness. Several beds of bentonite are interspersed with layers of shale. The total thickness of the bentonitic material is approximately [illegible]. The overburden varies greatly, but stripping operations are quite feasible over a large area. Estimates place the recoverable bentonite at 6,000 tons per acre.

Bentonite finds use as a filler in paper and other manufactured products. Of this material, referred to as the Morden Bentonite, [illegible] states in "Canadian Bentonites":

> "...the bentonite from the deposit near Morden, Manitoba, possesses, for a variety of petroleum and fatty oils, unusually high bleaching power. This bentonite in the crude state is very active, its activity approaching in many instances that of commercially used activated clay, and in some cases it is greater. Morden bentonite is further-

> more readily susceptible to activation, yielding an activated product that possesses far greater adsorbent power than any other clay examined in this laboratory, including industrial activated earths from the United States, Germany and France ....[1]

CEMENT

Materials for the manufacture of cement are abundant in Manitoba. The Portland cement industry requires limestone and argillaceous materials which are both widespread in southeastern Manitoba. Moreover, in the Niobrara beds of the western escarpment, there are calcareous shales of a composition suitable for the manufacture of natural cement.

Portland cement is manufactured at the plant of Canada Cement Company, Fort Whyte, on the outskirts of Winnipeg. Since its establishment in 1911, this plant has rapidly increased production until in 1928 close to 700,000 barrels were manufactured. It uses a high-grade limestone quarried at Steep Rock, on Lake Manitoba, crushed at the quarry and shipped 146 miles to the mill. It is there mixed with clay which is excavated from its pits about a mile west of the mill, the pits ranging in depth up to 10 feet from the surface. The mixture is approximately 2 limestone to 1 clay. The gypsum required is obtained from Gypsumville.

The company supplies the market from Dryden westward to Moose Jaw. In that area no shipment of cement crosses the boundary line in either direction.

The following is a typical analysis of the limestone at Steep Rock:

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[1] Canadian Journal of National Research, Sec.B, Vol. 16, p.9. Jan. '38

Moisture	0.09
Insoluble	1.01
Alumina and iron oxides	.35
Lime carbonate	96.73
Magnesium carbonate	1.38
Sulphur trioxide	.08
	99.64

CLAY

Clays and shales for the manufacture of common brick and allied clay products are widely distributed in Manitoba, particularly in the south and west. The chief materials and those so far used are surface clays, all of which are transported clays of recent origin, and Cretaceous shales which outcrop abundantly in the southwestern part of the province. With the exception of small amounts of the latter shales which are used for tapestry bricks, surface clays are the only ones used at the present time, and have been the most important source in the past. Some production resulted for a time from four brickworks designed to utilize shales from the Niobrara and Pierre formations. Many of the surface clays were transported by and deposited from ice-sheets. Others were laid down by rivers and in glacial lake basins. Besides being used for the manufacture of brick, tile and sewer pipe, surface clay is also used in the manufacture of Portland cement.

Kaolin and fireclays are probably scarce owing to the general absence of residual clays in Manitoba. A possible source for these materials is the upper part of the Pre-Cambrian floor, where weathered products have been protected from glacial erosion by overlying Palaeozoic beds. Such occurrences are most accessible along the boundary of Ordovician and Pre-Cambrian. Thin beds of clay, approaching kaolin in composition, occur on the shore of

Deer (Punk) Island, Lake Winnipeg. It is probably a residual clay, occurring at the base of the Ordovician.

COAL

The coal (lignite) beds of Manitoba are confined, as far as present knowledge goes, to the Tertiary formations of Turtle Mountain, and to the Dakota Sandstone, where thin lignite seams are found in the sandstone. The Turtle Mountain beds have been found in water wells, principally on the western and northern slopes of Turtle Mountain, in southwestern Manitoba. The Dakota sandstone seams are exposed on Swan River, Steep Rock River, and other erosion valleys on the east side of the Duck and Porcupine Mountains.

In general, the beds in the Dakota sandstone are in the nature of pieces of lignite showing clearly the wood-structure, forming together somewhat irregular seams or beds.

The Turtle Mountains reach an elevation of somewhat over 2,450 feet above sea level, the elevation at Boissevain, which is practically on the plain, being 1681. The coal measures are found from elevations of 1,734 to 1,898 feet above sea level, that is, within the 200 feet of strata overlying the Foxhill sandstone.

As early as 1896-7, attempts were made to mine the measures, 6 miles S.S.E. of Deloraine. Owing to the seams being of no greater thickness than 3½ feet, and covered with overburden to a depth of 90 feet in places, operations have not been carried on on any large scale. A local fuel market can and has been supplied by two small mines in the neighbourhood of Goodlands, working for the past four years. Recent production has been slightly in excess of 3,000 tons a year.

In an exposure on Swan River (S.E.$\frac{1}{4}$ Sec. 8, Tp. 37, Reg. 26W) 1 and 2 inch bands of lignite are separated by, on an average, four inches of sand. Sixty such bands can be counted in the section, which is underlain by a clay which contains considerable disseminated lignite material. The exposures of Dakota sandstone on Steeprock River on the eastern slope of the Porcupine Hills, and at the rapids on the Carrot River, in Saskatchewan, west of the Pasquia Hills, also show lignite bands, in the latter case of some thickness. The beds do not admit of working, as they are of very variable size, and have a roof of loose sandstone which would prove treacherous on excavation.

GYPSUM

Gypsum beds outcrop northwest of the narrows of Lake St. Martin, immediately north and northeast of Gypsumville. They have been operated continuously since 1900. These deposits are extensive, covering four and a half square miles of surface exposure, and will be available for surface quarrying for several decades at the present rate of production. Except at Elephant Hill, six miles from the town, where a high-grade variety of gypsum has been quarried, only the ridges immediately north of Gypsumville have yet been developed.

Gypsumville Quarry -- Since 1928 the operations in this district have been conducted by the Gypsum, Lime and Alabastine, Canada, Ltd. The main quarry of this company is on section 26, twp. 32, rge. 9, west of the Principal meridian. The average depth of the face in this quarry is 15 feet. The bedded gypsum is blasted and loaded by steam shovel into cars.

[illegible]

The company's mill, situated in the western outskirts of Winnipeg, manufactures a complete line of gypsum products.

Amaranth Mine — Until 1930 Manitoba's entire production of gypsum came from the Gypsumville area. During 1929, the Western Gypsum Products, Limited, was incorporated to mine gypsum at a point one mile south of the village of Amaranth, forty miles north of Portage La Prairie, on the west side of Lake Manitoba.

No exposure has yet been discovered, hence the work is entirely underground in contrast to the open-pit quarrying of the Gypsumville district.

A vertical two-compartment shaft extends to the bottom of the gypsum deposit at 130 feet. The thickness of the bed is approximately thirty-eight feet and almost the whole of it can be examined from the ladder-way.

Two levels have been opened up. The floor of the first level is 113 feet below the collar of the shaft, and drifts eight feet high have been cut for a distance of about 30 feet both north and south of the shaft.

The floor of the second level, or main working level, is 130 feet below the surface and corresponds to the bottom of the workable gypsum. The roof is nine feet above the floor. Room-and-pillar methods of working have been adopted and two main haulage ways extend north and south from the shaft. Broken rock is loaded into mine cars, which are raised to the surface and dumped automatically into gondola cars for transportation to the mill in Winnipeg.

General -- Gypsum has been found by drilling at Leifur, St. Charles, Rathwell, Arnaud, St. Elizabeth and Dominion City at varying depths, underlaid by red clay. No attempt has been made to mine these deposits.

OIL AND GAS

Of the rock formations that carry oil and gas in other parts of the world, there exist in Manitoba sediments of Palaeozoic, Mesozoic and Cenozoic age. The Palaeozoic representatives belong to the Ordovician, Silurian and Devonian systems and consist mainly of relatively undisturbed limestones, with a few calcareous shales and a basal sandstone. The Mesozoic is represented by Upper Cretaceous interbedded sandstones, shales and relatively few thin limestone beds. They, too, are relatively undisturbed. Formations of Cenozoic age in Manitoba seem to possess no possibilities for oil and gas.

Palaeozoic rocks cannot be regarded as favourable for oil and gas production in the province. They would not be good reservoir rocks, the limestones being typically massive. A few porous members, where exposed, have a strongly oxidized appearance, suggesting that at present, at least, there is no bituminous matter in the formations. The limestones have been penetrated by drills at several points, even to the underlying granite. Favourable structures are few and small, so far as they are known.

The presence of oil-shales in Cretaceous formations suggests that conditions for oil formation exist, but as yet there is no indication that oil has been separated from the shales and accumulated in pools. The drilling operations that have so far been conducted point the other way.

[illegible] has been carried on at many points in Manitoba. In the main, the [illegible] shales of [illegible] age (Benton and Niobrara) from which [illegible] in surface [illegible], have been responsible for the [illegible] at depth. These shales have been drilled [illegible], [illegible], [illegible] Mountain, Grandview, [illegible] in the [illegible] Hills west of the [illegible] line. If favourable structures are found, [illegible] at points well up the hills would be [illegible] to prospect for possible reservoirs.

[illegible] in the limestones of [illegible] Winnipegosis in a Devonian limestone [illegible] on the east side of Lake Manitoba, and at a [illegible]. In the [illegible] at Winnipegosis, the [illegible] occurs in Palaeozoic rock. The [illegible] to the granite without favourable [illegible] the granite was reached and pen[illegible]. The lower Palaeozoic limestones have been [illegible] to the granite in search of water without any [illegible] being disclosed.

[illegible] have been found at several places, occas[illegible] pressure. [illegible] wells have been dug to [illegible] in the Cretaceous shales, without [illegible]. The [illegible] shales of Niobrara age are probably the [illegible] which has, however, frequently migrated to other [illegible]. In [illegible] in Manitoba, natural gas has found use [illegible] for domestic lighting purposes; and in some [illegible] as well. The localities where gas

has been encountered are notably the Waskada-Sourisford area, southwest of Treherne, and south of Rathwell. In the two latter areas, the gas comes from carbonaceous shale in the Niobrara formation.

Recently attention has been given to areas near Pilot Mound and Manitou, both in geological study and drilling. Drilling has also been done in the Birdtail area, south of Riding Mountains.

OIL SHALE

Certain horizons in the Cretaceous shales which form the western escarpment of Manitoba are bituminous. This is particularly the case with the Niobrara shales, which are exposed in the Pembina River, Assiniboine River and the rivers which carve the Riding Duck and Porcupine Mountains. Such bituminous shales smell of oil in hot weather, burn in the fire, and show evidence of oil in nearby pools of water. They have been responsible for considerable search for oil by drilling. Their maximum oil content is 8 - 10 imperial gallons per ton, in the most favourable exposures, which is too low for successful extraction by distillation, even under favourable transportation conditions. Some specific occurrences of these shales are the following: Pembina River, South of Manitou, Assiniboine River, Northwest of Treherne, Ochre River, Vermilion River, Pine River, Sclater River, Favel River, as well as Old Man River in the Pasquia hills (Saskatchewan).

PEAT

Peat beds are characteristic of many of the swamp areas in Pre-Cambrian territory in eastern and northern Manitoba, and are being augmented by a fairly rapid growth of vegetation. The most

important beds yet surveyed lie in the valley of the Whitemouth River, and west of Pointe Du Bois; but extensive beds occur north of the Winnipeg River, northwest of Lac du Bonnet, also north of Saskatchewan River on the northwest end of Lake Winnipeg. An approximate total area of 242,000 acres of peat and litter bog has been surveyed in Manitoba, the most extensive being the bog east of Whitemouth, of which the investigated area is 97,000 acres, and the depth 11 to 12 feet. With the possible exception of the bogs immediately west of Pointe du Bois, the agricultural possibilities of these marshes are better when drained than are the fuel possibilities under present conditions, as the vegetation is not yet sufficiently humified for utilization in the peat industry.

In recent years sphagnum moss has been utilized as an insulating material in the Winnipeg area. In 1936 and 1937 approximately 325 tons of this material were taken near Cowan, mainly from section 11, tp. 36, rge. 23, west of the Principal meridian.

SALT

No salt beds have been found in Manitoba, but saline waters are common in springs and in some cases in wells.

<u>The Springs</u> --- The salt springs appear throughout a narrow strip of country extending in a southwesterly direction from Carrot River to the Red River valley, east of Pembina mountains, and measuring 320 miles in length and 40 miles in width. In every case they issue from Devonian limestones and dolomites and are usually found close to the base of the escarpment which extends from the Pasquia to the Pembina Hills. The most important springs occur in the upper beds of the Manitoba formation on the west side of Dawson Bay on Lake Winnipegosis and on Red Deer River. A few springs are known

west of Lake Manitoba near Crane Lake and Westbourne, and some appear in the Red River valley near La Salle and Morris. The spring areas are very similar in appearance, consisting of one or more springs bubbling up in the centre of a barren flat, sometimes more than 100 acres in extent, and devoid of all vegetation except the red salt plant.

The dissolved salts in the water from the springs on the west side of Lake Winnipegosis average 5.5 to 6 per cent. This is much greater than in the southern areas, but compares unfavourably with the brines of Ontario and Michigan which contain from 23 to 25 per cent dissolved salts. The flow from 84 separate spring areas has been estimated at 430 gallons per minute, this representing approximately 52,500 tons of salt brought up annually.

<u>The wells</u> --- South of Lake Manitoba the presence of salt water horizons has been ascertained mainly by deep boring. Wells or bore holes have struck salt water at Jamestown, Deloraine, Rosenfeld, Morden, Manitou, Neepawa, Gladstone, Rathwell and Winnipeg. Unfortunately, little direct information is available concerning the greater number of these springs. The wells at Jamestown, Deloraine, Morden, Manitou and Rathwell appear to have tapped a flow in the Dakota sandstone. Three horizons were struck in the Neepawa well, the uppermost in the Dakota sandstone, the lower two in the Ordovician and possibly Silurian horizons. Wells at Winnipeg and Rosenfeld showed a flow in Ordovician strata but the concentration in these is weak, being 3.2 and 4.32 respectively.

Some of the brines are said to have a medicinal value, apart from their salt content, and might be worthy of development for this purpose. Water from the Elmwood well is being used in the

baths of the Sanatorium as a cure for muscular ailments. It is also carbonated and sold as a beverage. At Barrows and Ste. Rose du Lac, brines from Devonian horizons make a very attractive hot weather drink and have a local reputation as a remedy for kidney troubles.

At Neepawa a salt well has been producing brine since 1932. In this well, flows of strong brine were encountered at 1,185 feet and 1,460 feet and rose to within 200 feet of the collar of the well. Analyses of this brine, made before the commencement of production, showed 17 per cent dissolved salts, over 85 per cent of which is sodium chloride.

Operations at Neepawa have been continuous for nearly six years and the salt content has remained constant. During 1937, 11,000 gallons of brine were pumped daily and 3,391 tons of salt produced. The plant at Neepawa is controlled by Canadian Industries, Limited.

SAND AND GRAVEL

Sand and gravel deposits are very plentifully distributed over all parts of Manitoba. They occur as beaches of ancient glacial lakes, as fluvio-glacial eskers, and as outwash fans, all formed when the ice-sheets of Pleistocene times melted northwards. In the beaches (grouped principally along the Manitoba escarpment) there is a certain uniformity of texture, but in fluvio-glacial material, such as is found in ridges and irregular masses east of the Red River, sand and gravel succeed each other in sharpest contrast. The pebbles of the gravel beds are mainly granite and limestone, the percentage of limestone increasing with the distance from the eastern boundary of the province. In places (as at Birds' Hill) the pebbles are sufficiently

massive to provide material for a crushed stone industry.

The sand ridge at Beausejour supplied the sand for some years for a bottle-glass industry. After the plant was shut down in 1913, sand was shipped to the glass factory at Redcliff, Alberta. The possibilities of the soft sandstone on Elk Island and Black Island as a raw material for a glass industry are worthy of attention. Moulding sands for foundry work are obtained at mile 80, G.W.W.D. line, at Marchand (core sand) and at Melbourne. For heavy work Black Island sand is used, and is partly replacing the Ottawa (Illinois) sand. As parting sand in the brick industry, sand from Molson, St. Owens, mile 80 G.W.W.D. line and Ste. Rose du Lac is used. For sand lime brick it is obtained from Smith's Siding and from Marchand. For concrete, mortar and general purposes sand is got from Woodlands, Birds' Hill, Marchand, Ste. Anne's, Smith's Siding and Molson.

With increasing attention being paid to road construction, the demand for gravel has grown rapidly. There are many gravel pits distributed throughout Manitoba. The most extensive operations for the Winnipeg market are south of Woodlands and along the Birds' Hill ridge. The long beach ridges extending from the Pembina hills to the Porcupine mountain have been tapped at several points for local use.

STONE

Manitoba is well supplied with stone for building and to meet many other needs as well. Limestones are quarried to supply dimension stone for building purposes. Others, low in magnesia,

find their way into the cement industry. Varieties, both high and low in magnesia content, are burned into lime, much of which is absorbed by pulp mills for use in their paper-making processes. A great deal of limestone has also been quarried and used for crushing into materials for use in roads and concrete construction. A little has been absorbed by foundries for fluxing purposes. Attempts have been made to open granite quarries to supply material for monuments and crushed stone, but so far no permanent industry has been established. The Pre-Cambrian areas have a great variety of granitic rocks, which may some time be developed. Moreover, there is in the glacial drift, found in most parts of the province, an abundance of granite and other boulders, that have been found useful for local building purposes and may be an important source of road metal. Sandstones occur in three geological horizons within the province. The Winnipeg sandstone at the base of the Ordovician has a notable outcrop on Black Island, Lake Winnipeg. The Dakota sandstone at the base of the Cretaceous has outcrops at several places in the western escarpment. A sandstone from a higher horizon in the Cretaceous outcrops near Boissevain. Except for a small local use of the last named stone, the sandstones are not promising as sources of dimension stone. They are generally too soft. The Winnipeg sandstone consists almost entirely of silica, and it has great commercial possibilities.

Limestone --- The limestones, including dolomites, are all of Palaeozoic age. They are at present almost the sole source of stone for the different uses. The Upper Mottled limestone occurs in beds which are thick enough to supply building stone of large dimension.

[illegible] with a beautiful mottled [illegible], suitable for both interior and exterior finishes. This stone is quarried on a large scale at the Garson (Tyndall) quarries, situated near one of the main lines of the Canadian Pacific railway, about 25 miles northeast of Winnipeg. Manitoba Mottled limestone is finding a wide market in various parts of Canada for the larger and more expensive public and commercial buildings.

A limestone of Devonian age is quarried at Steeprock, Lake Manitoba, by the Canada Cement Company, for use in its plant at Fort [illegible]. A thickness of 12 feet of thin-bedded limestone is utilized. The average analysis shows the rock to be very high in lime, [illegible] per cent calcium carbonate. Other rocks with a low content of magnesia are known also to outcrop at Spearhill, Oakpoint, [illegible], [illegible] Point and Point Wilkins. The Spearhill limestone furnishes material for burning into lime, the bulk of which is used in the pulp-and-paper and mining industries.

At Stonewall, beds near the base of the Silurian are quarried and used for the manufacture of lime. Crushed stone is an occasional by-product. Similar rocks are exposed in quarries at Gunton, Inwood and [illegible] Valley. They also outcrop at several points along the [illegible] River. Though high in magnesia, the lime from this stone is very desirable for some purposes and finds a large market in the paper industry.

Granite — Granite and related rocks are abundant as bedrock in the Precambrian areas. A promising quarry has been opened at section [illegible], tp. [illegible], range [illegible], east of the Principal meridian. This is adjacent to the [illegible] railway just east of West Hawk Lake. The stone has been tested and when dressed makes an excellent gray "granite"

for monumental purposes.

A black "granite" has recently been quarried at section 17, tp. 9, rge. 17, east of the Principal meridian. It is quite probable that several varieties of monumental stone will be produced in the West Hawk Lake area.

Marble --- Of interest are the occurrences of so-called marble on the Hudson Bay Railway at Cormorant Lake, about 40 miles northeast of The Pas. Fine-grained Palaeozoic limestones occur here, which take a high polish and offer promising possibilities as sources of commercial marble. A variety of pleasing tints, commonly yellows and reddish browns, are produced by different layers of flat-lying limestones.

Sandstone --- There are three sandstone horizons in the province -- the Winnipeg sandstone, exposed at Elk Island, Black Island, Deer Island and Punk Island on Lake Winnipeg; the Dakota sandstone, showing at the south end of Swan Lake, on Swan River, Steep Rock River and Red Deer River; and the Fox Hill sandstone south of Boissevain. This last sandstone has found a local use in Boissevain as a building material. The Dakota sandstone is very friable, is easily accessible only on Swan River, and owing to its distance from large centres is of no immediate economic value. The Winnipeg sandstone on Elk Island and on Black Island is a loosely consolidated sand of remarkable purity. It is readily available for lake transportation and except in its lowest beds is not stained with iron. The most available exposures are on the south shore of Black Island, east of the iron deposits.

WHAT MINING DOES FOR MANITOBA

Mines offer steady work at good wages. They support other industries to a marked degree. They have increased railway traffic and have added a nearer-home market for farm products.

Mining areas have assisted in advancing aviation also. In turn, many mining communities of to-day are made possible by the aeroplane.

CHAPTER 13

To the end of 1930 the mineral industry in Manitoba was more or less in an experimental stage and the total production of metals up to that year from a number of properties working periodically was only $4,155,843. Since that year, however, metal production has exceeded $7,000,000 annually. The year 1937 closed with two base metal producers and six gold producers.

The growth of the mining industry in Manitoba may have been slow. It certainly has not been spectacular but nevertheless the prospector's efforts have created thriving towns and busy communities, and truly it may be said of the prospector that he has done more in this generation than any other person to bring the wilderness from obscurity to world-wide attention.

Of themselves the mines have offered inducement for work at good wages. Nor has that work been of a seasonable nature, for mining operations are carried on every month of the year. In their coming, mines have increased railway traffic and have aided a nearer-home market for farm produce. The mines, too, have made for steady support of many other industries, such as in lumber, machinery, and supplies chemical, iron and steel.

As an instance of what these mean to Manitoba, a list of expenditures for the year 1936 is given, together with wages paid at operating mines in 1937:

EXPENDITURES IN THE MINERAL INDUSTRY
1 9 3 6

	Non-Metallic Industry	Metal Producing Mines	Metal Mines in Process of Development
Coal	$ 137,963.00	$ 302,095.00	$ 2,487.00
Gasoline, etc	6,623.00	25,638.00	12,970.00
Fuel Oil	5,885.00	30,737.00	8,123.00
Wood	21,862.00	37,717.00	12,637.00
Electric Power	49,806.00	201,848.00	17,235.00
Supplies	108,191.00	4,021,104.00	53,356.00
Salaries	116,118.00	543,347.00	49,716.00
Wages	189,506.00	3,540,209.00	242,854.00
Totals	635,954.00	8,702,695.00	399,378.00

TOTAL - - - - - - - - - - - - - -	$ 9,738,027.00
Explosives - - - - - - - - - -	457,000.00
Lumber - - - - - - - - - - - -	120,000.00
	$10,315,027.00

1 9 3 7

Mine	Employees (average)	Payroll (approximate)	Remarks
Beresford Lake	24	$ 9,700	Suspended operations at end of March.
J.D.Shannon	23	3,425	Leased to J.D.Shannon who operated during December.
Cain, Geo.	11	2,300	6 months season operation.
Central Manitoba	160	113,250	Estimate 'till Aug.31,1937. From the beginning of June the payroll decreased rapidly.
Consolidated Diana	40	13,200	Operated 'till the end of March, 1937.
God's Lake	150	240,000	Payroll fluctuates considerably due to freighting.
Gunnar	96	150,000	
Gurney	60 - development -May 120 - construction-Sept. 100 - production	159,000	Payroll erratic during development and construction
H.B.M & S.	1,650	2,520,000	
Laguna	100	156,000	
Nestibo, J.	7	1,100	5 months seasonal operation.
Packsack	24	32,400	Operations suspended October 30, 1937.
San Antonio	200	324,000	
Sherritt Gordon	60 - preparation period 350 - production,Aug.1.	290,800	Payroll fluctuated considerably during preparation period.
Western Gypsum	12	7,000	Operated for 8 months.
Bergold	10	10,400	Operations for 8 months
Century	35	36,400	Operated for 8 months.

MANITOBA AND ADJACENT MINING FIELDS

In supplying the new mining empire of Northern Canada, Manitoba is in a strategic position. Its markets extend from Quebec on the east to the Great Bear area of the Northwest Territories.

CHAPTER [illegible]

One of the notable features in the economy of Mid-West Canada in the past decade has been the growth of a mining industry of substantial proportions in the territory between Long Lac, Ontario and Great Bear Lake, Northwest Territories, of which Winnipeg is the financial and the mercantile metropolis.

Year by year and particularly so since 1934 when the United States administration fixed the price of gold at $35.00, the mining industry in this area has expanded. In 1926, the only mining company in the area was Central Manitoba Mines, Limited, which went into production in November of the previous year, and the company's production in 1926 amounted in value to $466,571 (gold at $20.67 per oz.). During 1937, twenty six companies in production, milling daily around [illegible] tons, accounted for gold, silver, copper, zinc, selenium, [illegible], [illegible], [illegible], lead and tellurium to the value of [illegible], divided by provinces as follows: Western Ontario, [illegible]; Manitoba, [illegible]; Saskatchewan, $7,466,017; one company in Great Bear Lake, [illegible]. Since the beginning of 1938, four more companies have started the production of gold, with a daily milling average of [illegible]; five others are building mills whose daily capacity will be [illegible] tons; and there are probably another dozen where mills are in prospect.

In Winnipeg a large part of the purchases made by mining companies is placed with the manufacturers and merchants who established themselves here in the days when the tide of empire was rolling westward over the prairies, as well as with eastern manufact-

urers who have found it a convenience both to themselves and to companies whose custom they seek to carry on their business in this province. From Winnipeg the benefits of mining are diffused into the farming sections. The products of the farms are concentrated here and distributed to the mining companies, and the payments the latter make in return are banked here and distributed throughout the prairies. Thus it has been estimated, by way of example, that Manitoba mines alone take the complete dairy, meat and poultry production from 2,000 Manitoba farms, and additionally 150,000 gallons of milk or their dried equivalent, 40,000 bushels of potatoes, and 3,000,000 pounds of flour.

That is business that the farming communities did not have ten years ago. The benefits have been felt throughout Manitoba - agricultural land, rural town and metropolitan area, all have benefited. Winnipeg is the market where the farmer sells his products to the miner. But these products are not entirely farm produce. A large proportion is in hardware, clothing, machinery, etc., by a sort of alchemy in which Winnipeg residents eat farm produce to provide the energy they use in making or merchandising or warehousing the things that the miners buy to carry on their work.

In this new mining empire, the heavy Winnipeg industries can sell their products from Long Lac to Great Bear Lake, but the hardware merchants and the grocers, for example, find their boundaries limited by competition from Toronto, Fort William and Edmonton. Manufacturers actually located in Ontario and Quebec have their representatives in Winnipeg, and in the case of a manufacturer of explosives, a factory at Selkirk supplies mining companies from a strategic central position. On the other hand, the meat packers of Winnipeg and St. Boniface sell their products as far east as Quebec. Geography, therefore, is one

advantage that Winnipeg has in competition with other cities.

Capitalizing on this, the Manitoba capital has built up a large supply centre with continually on hand hardware, building materials, electrical supplies, machines and tools, clothing and footwear, oils and greases, cookhouse and bunkhouse outfits, groceries and meats, chemicals and drugs, paints and varnishes, tractors and trucks, etc - probably the most suitable and best selected line of distributor stocks carried anywhere in Canada.

Additionally, there are in Winnipeg founders, fabricators and steel workers whose prices on a wide line of mining supplies which they manufacture are competitive as far east as Long Lac and Beardmore, in Ontario, and west to Lake Athabaska and Great Bear Lake. Many articles, such as mine cars, cages and the smaller hoists, are standardized so that parts can be made and kept in stock for prompt delivery when an order is placed, as well as serving replacement needs.

Next there are the speed and frequency of transportation services. Thus Red Lake and Pickle Crow areas in Ontario are served by daily air services, passenger, mail and express, and in fact these mining camps, 150 and 200 miles distant from Winnipeg, are as fortunately placed in respect to quick delivery as towns 25 to 50 miles away. The extent of air mail business in the Winnipeg postal district can be judged from postal returns for March, namely, 35,448 pounds flown to settlements in the mining areas.

Winnipeg, therefore, makes its bid for the mining business on these four prime factors: Time, Cost, Stocks and Specialists who know the particular needs of the territory they serve.

GEOLOGICAL MAPS (MANITOBA)

1917 - 1937

The following maps have been published by the Geological Survey of Canada, the Department of Mines and Resources, Ottawa, and the Department of Mines and Natural Resources, Manitoba, since the year 1917. A large number of maps which were issued prior to 1917 by the geological and topographical departments of the Dominion Government have since gone out of print but as the material contained therein has been largely incorporated in more recent publications, these may be referred to for any desired information.

1391 (135-A) Lower Churchill River. Lat. 57° 00' to 59° 00'; long. 94° 00' to 99° 00'; scale 1 inch to 16 m; geology. (1918)

1670 Schist Lake district. Scale 1 in. to 2 m.; geology. (1917).

1671 Wekusko Lake. Scale 1 in. to 2. m.; geology (1917).

1672 Diagram showing gold-bearing deposits in the vicinity of Big Clearwater Lake. Scale 1 in. to $\frac{3}{4}$ m.; geology. (1917).

1692 Amisk and Athapapuskow Lakes. Lat. 54° 23' to 54° 59'; long. 100° 45' to 102° 24'; scale 1 in. to 4 m; geology. (1917).

1726 Athapapuskow Lake region. Lat. 54° 15' to 55° 00'; long. 100° 45' to 102° 30'; scale 1 inch to 3 m; geology. (1919).

1763 Portion of the Rex group of claims, Wekusko Lake Scale 1 in. to 200 ft.; geology. (1919).

1771 Winnipegosis. Lat. 51° 32' to 52° 15'; long. 99° 35' to 100° 43'; scale 1 in. to 3 m.; surface geology. (1921).

1801 Reed and Wekusko Lakes region. Lat. 54° 30' to 55° 02'; long. 99° 25' to 100° 43'; scale 1 in. to 2 m.; geology. (1920).

1802 Upper Whitemouth River. Lat. 49° 00' to 49° 52'; long. 95° 10' to 96° 30'; scale 1 in. to 3 m.; surface geology. (1921).

1838 Rat River route from Three point Lake to Southern Indian Lake. Scale 1 in. to 8 m.; geology (1921)

[illegible]

1839 The terminal moraine of the Seal-Churchill divide. Scale 1 in. to 6 m.; geology. (1921).

1841 Diagram showing Maskwa River nickel-copper deposits Scale 1 in. to $\frac{3}{4}$ m.; geology. (1922).

1861 The Ospwagan Lake-Burntwood River area. Lat. 55° 27' to 55° 49'; long. 97° 50' to 98° 20'; scale 1 in. to 2 m.; geology. (1921).

1928 Oiseau River area. Scale 1 in. to $\frac{3}{4}$ m.; geology. (1922.).

1929 Rice Lake area. Scale 1 in. to $\frac{3}{4}$ m.; geology. (1922).

1978 Part of the Flin-Flon group of claims. Scale 1 in. to 250 ft.; geology. (1923).

1992 Preliminary map of a portion of Rice Lake mining district. Lat. 50° 51' to 51° 07'; long. 95° 30' to 95° 56'; scale 1 in. to 1 m.; geology. (1923).

1994 Flin Flon Lake Area. Lat. 54° 42' to 54° 49'; long. 101° 48' to 101° 58'; scale 1 in. to $\frac{1}{2}$ m.; geology;. (1925)

1995 Cross and Pipestone Lakes area. Lat. 54° 25' to 54° 50'; long. 97° 17' to 98° 10'; scale 1 in. to 2 m.; geology. (1924).

2012 Beresford Lake area, Rice Lake mining district. Lat. 50° 51' to 50° 58'; long. 95° 13' to 95° 28'; scale 1 in. to 1 m.; (1925)

2059 Oiseau River area. Lat. 50° 16' to 50° 30'; long. 95° 09' to 95° 49'; scale 1 in. to 1 m.; geology. (1925).

2109 Oxford and Knee Lakes area. Lat. 54° 40' to 55° 10'; long. 94° 20' to 96° 05'; scale 1 in. to 2 m.; geology. (1926).

2110 Bigstone and Fox Rivers area (three sheets). Scale 1 in. to 2m.; geology. (1926).

2137 (195-A) Beresford and Rice Lake area. Lat. 50° 40' to 51° 05'; long. 95° 09' to 95° 47'; scale 1 in. to 1 m.; geology. (1927)

2160 (211-A) Island Lake area. Lat. 53° 36' to 54° 05'; long. 93° 36' to 95° 08'; scale 1 in. to 2 m.; geology. (1928).

2194 (233-A) Reindeer Lake area. Lat. 56^{0} 15' to 58^{0} 08'; long. 101^{0} 23' to 103^{0} 22'; scale 1 in. to 6 m.; geology. (1929)

2195 (234-A) Kississing Lake area. Lat. 54^{0} 56' to 55^{0} 30'; long. 100^{0} 50' to 102^{0} 00'; scale 1 in. to 2 m.; geology. (1929).

2199 Sherritt-Gordon deposit, Kississing lake. Scale 1 in. to 800 feet; geology. (1929).

2245 (254-A). Winnipeg sheet. Lat. 49^{0} to 52^{0}; long. 95^{0} to 102^{0}; scale 1 in. to 8 m.; surface deposits. (1921.)

2272 (268-A) The Pas sheet. Lat. 52^{0} to 55^{0}; long. 96^{0} to 103^{0} 30'; scale 1 in. to 8 m. geology. (1934).

2291 (280-A) Wadhope area. Twp. 22, Rge. 16 E.P.M.; geology; scale 1 in. to 2000 feet. (1932).

2357 (305-A) Oxford House sheet. Lat. 54^{0} to 55^{0}; long. 94^{0} to 96^{0}; scale 1 in. to 4 m.; geology. (1934).

2381 (321-A) Elbow-Morton area. Lat. 54^{0} 35' to 54^{0} 58'; long. 100^{0} 26' to 100^{0} 58'; scale 1 in. to 2 m. geology. (1935).

(343-A) Granville Lake sheet (west half) Lat. 56^{0} to 57^{0}; long. 101^{0} to 102^{0}; scale 1 in. to 4 m.; geology. (1936).

(344-A) Granville Lake sheet (east half) Lat. 56^{0} to 57^{0}; long. 100^{0} to 101^{0}; scale 1 in. to 4 m.; geology. (1936).

(345-A) Seal River (a portion of) Lat. 58^{0} 30' to 59^{0} 30'; long. 94^{0} to 99^{0}; scale 1 in. to 4 m. geology. (1936)

(346-A) Seal River Area. Lat. 57^{0} to 60^{0}; long. 94^{0} to 100^{0}; scale 1 in. to 12 m.; geology. (1936).

374A-375A-376A Herb Lake area (3 sheets); a portion of the east shore of Herb Lake. Scale 1 in. to 1000 ft. geology. (1936)

Echimamish area (advance copy) acc. rept. 37-18. Geology of Volcanics and Sediments on Echimamish River. Scale 2 in. to 1 m. (1937).

Stull Lake area (advance copy) acc. rept. 37-7. Lat. 54^{0} to 55^{0}; long. 92^{0} to 94^{0}; scale 1 in. to 2 m.; geology. (1937)

Ontario-Manitoba boundary. From Winnipeg River north to Bloodvein river. Scale 1 in. to 2 m.; geology. (1923).

Ontario-Manitoba boundary. From Bloodvein river north to angle at 12th Base line. Scale 1 in. to 2 m.; geology. (1923).

Ontario-Manitoba boundary. From the angle at the 12th Base line, Manitoba, northeast to Island Lake. Scale 1 in. to 4 m. (1931).

Map of Manitoba showing mineral areas, mining districts and mining divisions. Department of Mines and Natural Resources. (1938).

[illegible]

[illegible] Manitoba's [illegible] The following [illegible] of wider [illegible] possible [illegible] needed [illegible] bibliographies in [illegible]

[illegible] Bulletin [illegible] 1929. [illegible]

[illegible] Manitoba Govern- [illegible]

[illegible] Industrial Development Board [illegible] Wallace.

[illegible] Natural Hist. Soc. [illegible] Wallace. [illegible]

[illegible] Industrial [illegible]

[illegible] Industrial [illegible] Wallace and [illegible]

[illegible] Summary [illegible] 1930. [illegible]

[illegible] Department [illegible] 1930. [illegible] complete bibliography to date.

[illegible] Knight.

[illegible] Geological Survey of Canada, [illegible] 1930. ([illegible] Hume).

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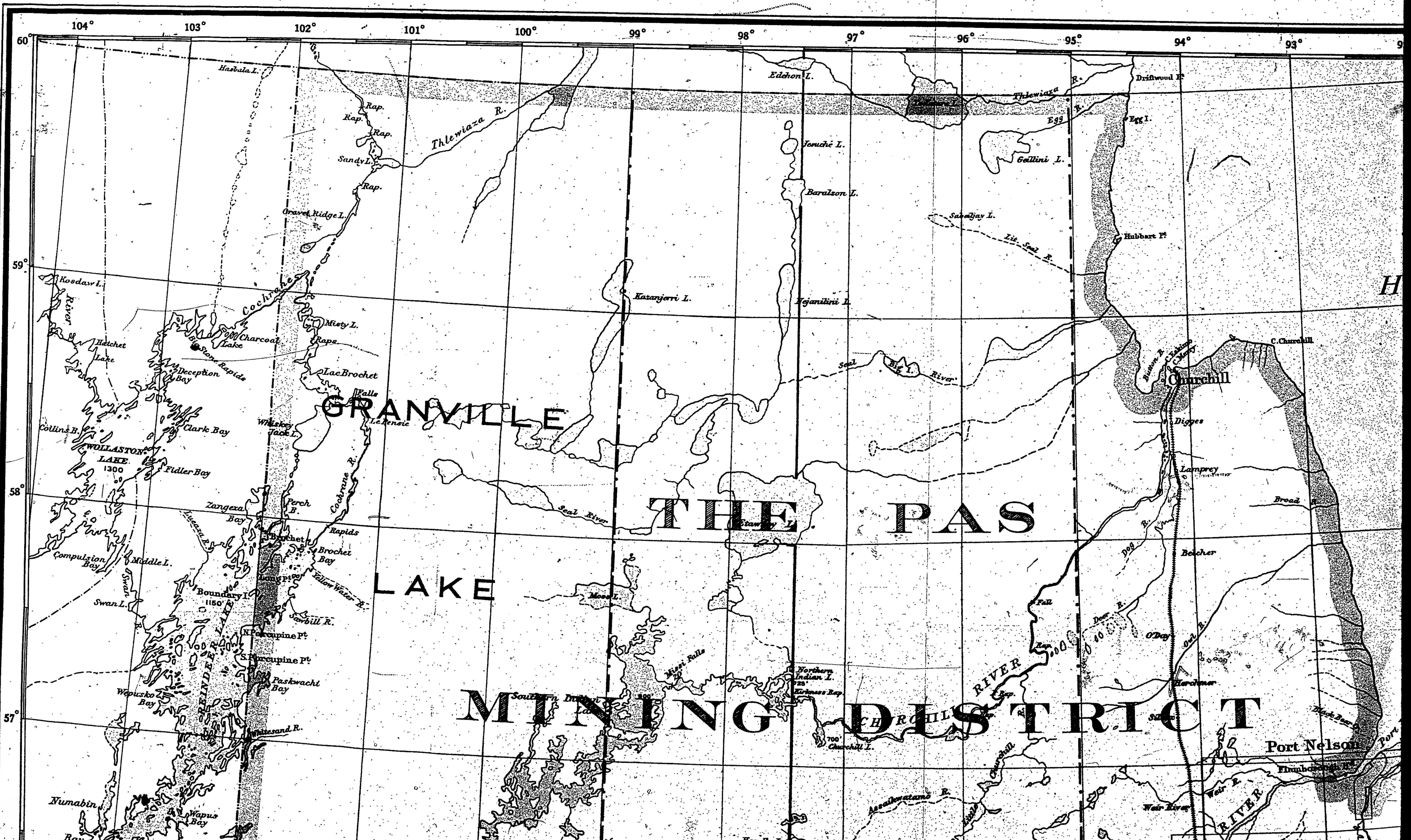

104°
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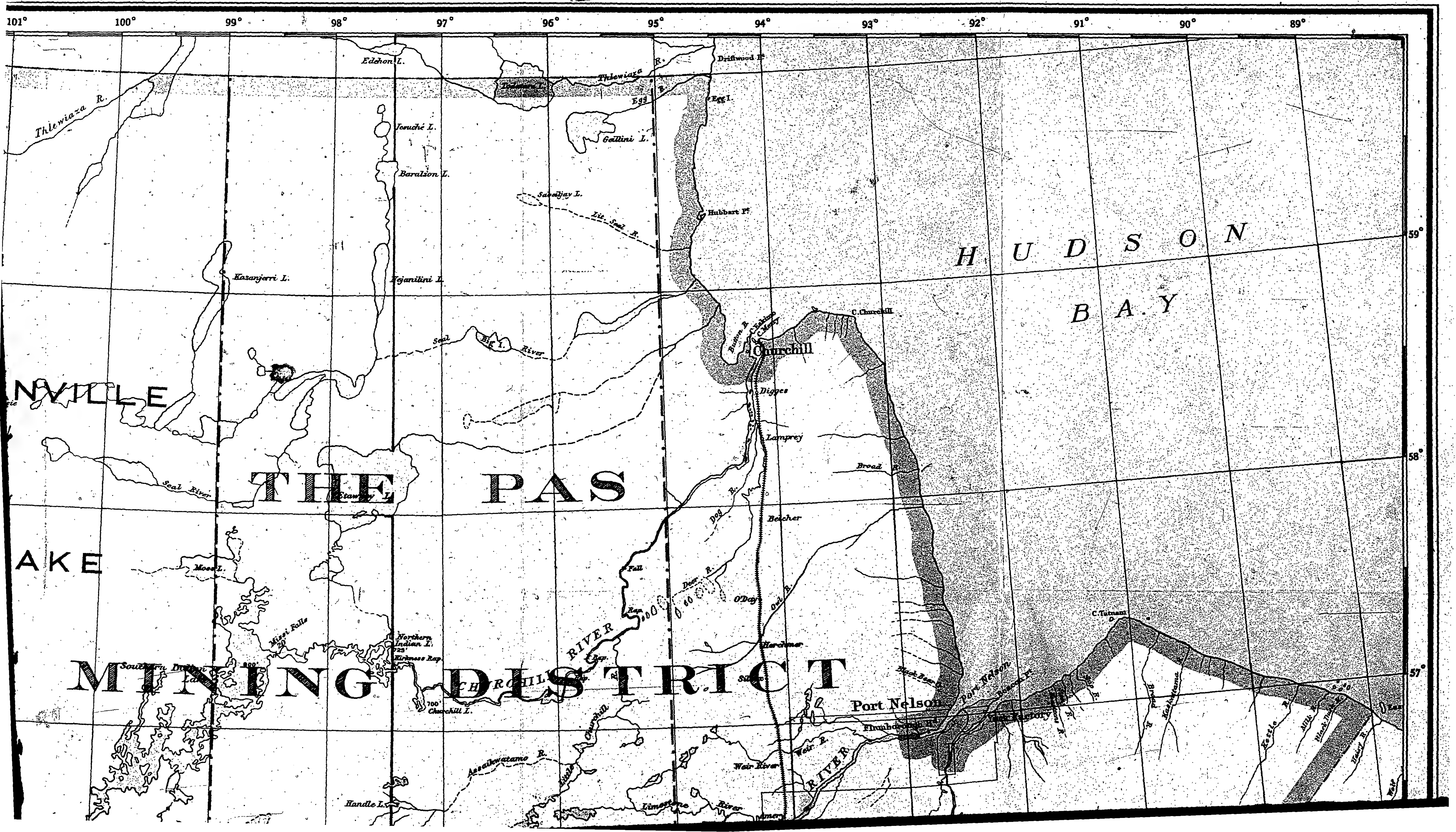
57°
GRANVILLE
LAKE
THE PAS
MINING DISTRICT
Hasbula L.
Edehon L.
Driftwood Pt.
Thlewiaza R.
Egg R.
Egg I.
Rap.
Sandy L.
Josuché L.
Gellini L.
Baralzon L.
Gravel Ridge L.
Sabeljay L.
Lit. Seal R.
Hubbart Pt.
Kosdaw L.
River
Cochrane
Kazanjerri L.
Nejanilini L.
Misty L.
Charcoal Lake
Hatchet Lake
Big Stone Rapids
Raps.
Lac Brochet
Falls
Seal River
Big I.
Deception Bay
C. Churchill
Churchill
Clark Bay
Whiskey Jack L.
Le Pensie
Collins B.
WOLLASTON LAKE
1300
Fidler Bay
Digges
Lamprey
Zangeza Bay
Perch B.
Cochrane R.
Broad
Seal River
Stanley L.
Rapids
Brochet
Brochet Bay
Compulsion Bay
Middle L.
Dog R.
Belcher
Long Pt.
Yellow Water R.
Boundary I.
1150
Swan L.
Moose L.
Fall
Deer R.
O'Day
Owl R.
N. Porcupine Pt.
Sawbill R.
S. Porcupine Pt.
Missi Falls
Northern Indian L.
Kirkness Bay
Paskwachi Bay
Wepusko Bay
REINDEER LAKE
Southern Indian Lake
RIVER
CHURCHILL
Rap.
Herchmer
Whitesand R.
700
Churchill L.
Port Nelson
Numabin
Wapus Bay
Bay
Assiniboine R.
Little Churchill R.
Weir River
Weir R.
RIVER
Handle L.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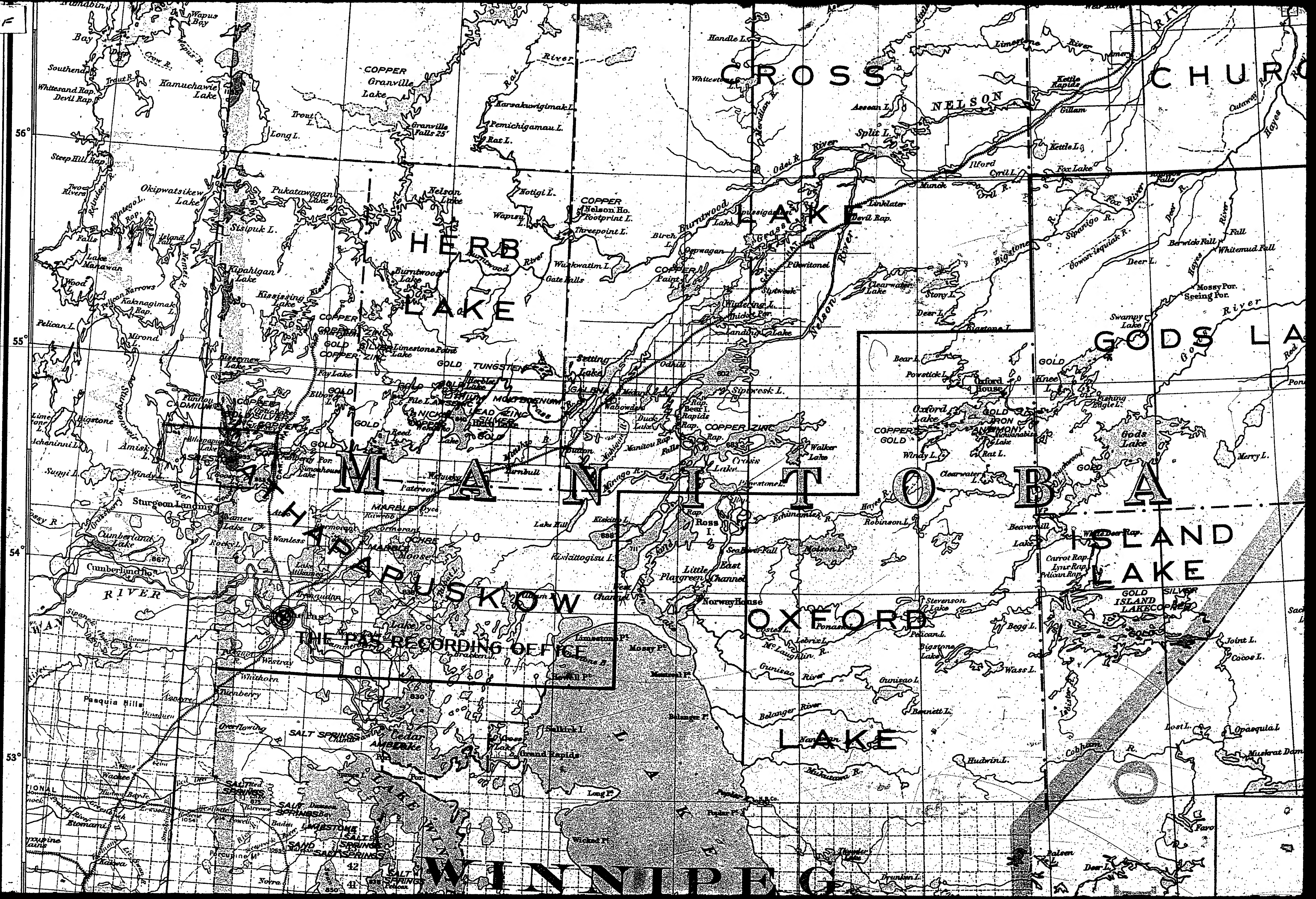
HUDSON
BAY
Thlewiaza R.
Thlewiaza R.
Edehon L.
Driftwood Pt.
Egg I.
Egg R.
Jesuché L.
Gellini L.
Baralzon L.
Hubbart Pt.
Lit. Seal R.
Kazanjerri L.
Nejanilini L.
C. Churchill
Seal
Big I.
River
Churchill
Digges
Lamprey
Broad
NVILLE
THE PAS
Seal River
Dog R.
Beicher
AKE
Moss L.
Fall
Deer R.
O'Day
Owl R.
C. Tatnam
Northern Indian L.
Churchill L.
RIVER
MINING DISTRICT
Port Nelson
Port Nelson
Beacon Pt.
York Factory
Weir R.
Weir River
Limestone
River
Handle L.

3 OF



CROSS LAKE
CHURC
NELSON
HERB LAKE
MANITOBA
ATHAPAPUSKOW
THE PAS RECORDING OFFICE
OXFORD LAKE
GODS LA
ISLAND LAKE
WINNIPEG
COPPER
Granville Lake
Granville Falls 25'
Kamuchawie Lake
Southend
Whitesand Rap.
Devil Rap.
Trout L.
Long L.
Steep Hill Rap.
Okipwatsikew Lake
Pukatawagan Lake
Nelson Lake
Notigi L.
Wapusu L.
Nelson Ho.
Footprint L.
Threepoint L.
Karsakuwigimak L.
Pemichigamau L.
Rat L.
Rat River
Handle L.
Limestone River
Kettle Rapids
Gillam
Assean L.
Split L.
Odei R.
Kettle L.
Fox Lake
Ilford
Cyril L.
Munck
Linklater
Devil Rap.
Burntwood
Birch L.
Burntwood Lake
Wuskwatim L.
Gate Falls
Sisipuk L.
Kipahigan Lake
Kississing Lake
Pelican Narrows
Kakinagimak Rap.
Pelican L.
Mirond L.
Lake Manawan
Wood L.
Paint L.
Pikwitonei
Wintering L.
Thicket Por.
Landing Lake
Nelson River
Clearwater Lake
Stony L.
Deer L.
Bigstone L.
Bigstone
Sipanigo R.
Gowan-isquiak R.
Berwick Fall
Whitemud Fall
Mossy Por.
Seeing Por.
Swampy Lake
Gods River
GOLD
COPPER
ZINC
Limestone Point Lake
TUNGSTEN
Setting Lake
Fay Lake
Elbow L.
MOLYBDENUM
LEAD ZINC
SILVER
NICKEL
CADMIUM
Bigstone
Amisk L.
Suggi L.
Windy L.
ASBESTOS
Sturgeon Landing
Cumberland Lake
Cumberland Ho.
RIVER
Paterson
Turnbull
Sipiwesk L.
Odhill
Bear L.
Oxford House
Oxford Lake
Knee L.
Fishing Eagle L.
Powstick L.
IRON
ANTIMONY
Rat L.
Windy L.
Clearwater L.
Gods Lake
Merry L.
Duck Lake
Manitou Rap.
Walker Lake
Cross Lake
Limestone L.
Kisipichi
Lake Hill
Ross I.
Echimamish R.
Hayes R.
Robinson L.
Beaver Hill Lake
Nelson L.
Sea River Fall
Little Playgreen
East Channel
West Channel
Norway House
MARBLE
OCHRE
Moose
Cormorant
Wanless
Rocky L.
Lake Atikameg
Kisiditogisu L.
Carrot Rap.
Lynx Rap.
Pelican Rap.
ISLAND LAKE
SILVER
COPPER
Stevenson Lake
Ponask
Oster L.
Lebrix L.
McLaughlin R.
Pelican L.
Begg L.
Bigstone Lake
Wass L.
Gunisao River
Gunisao L.
Bennett L.
Belanger River
Joint L.
Cocos L.
Limestone Pt.
Mossy Pt.
Sowell Pt.
Westray
Whitehorn
Turnberry
Pasquia Hills
Overflowing
SALT SPRINGS
Cedar Lake
AMBER
Selkirk I.
Grand Rapids
Belanger Pt.
LAKE
Hudwin L.
Lost L.
Opasquia L.
Cobham R.
Muskrat Dam
Wachee
Hudson Bay Jc.
Etomami
Long Pt.
Poplar Pt.
Wicked Pt.
Porcupine Mt.
SALT SPRINGS
SAND
LIMESTONE
42
41
Drunken L.
Deer L.
Faro
Raleen
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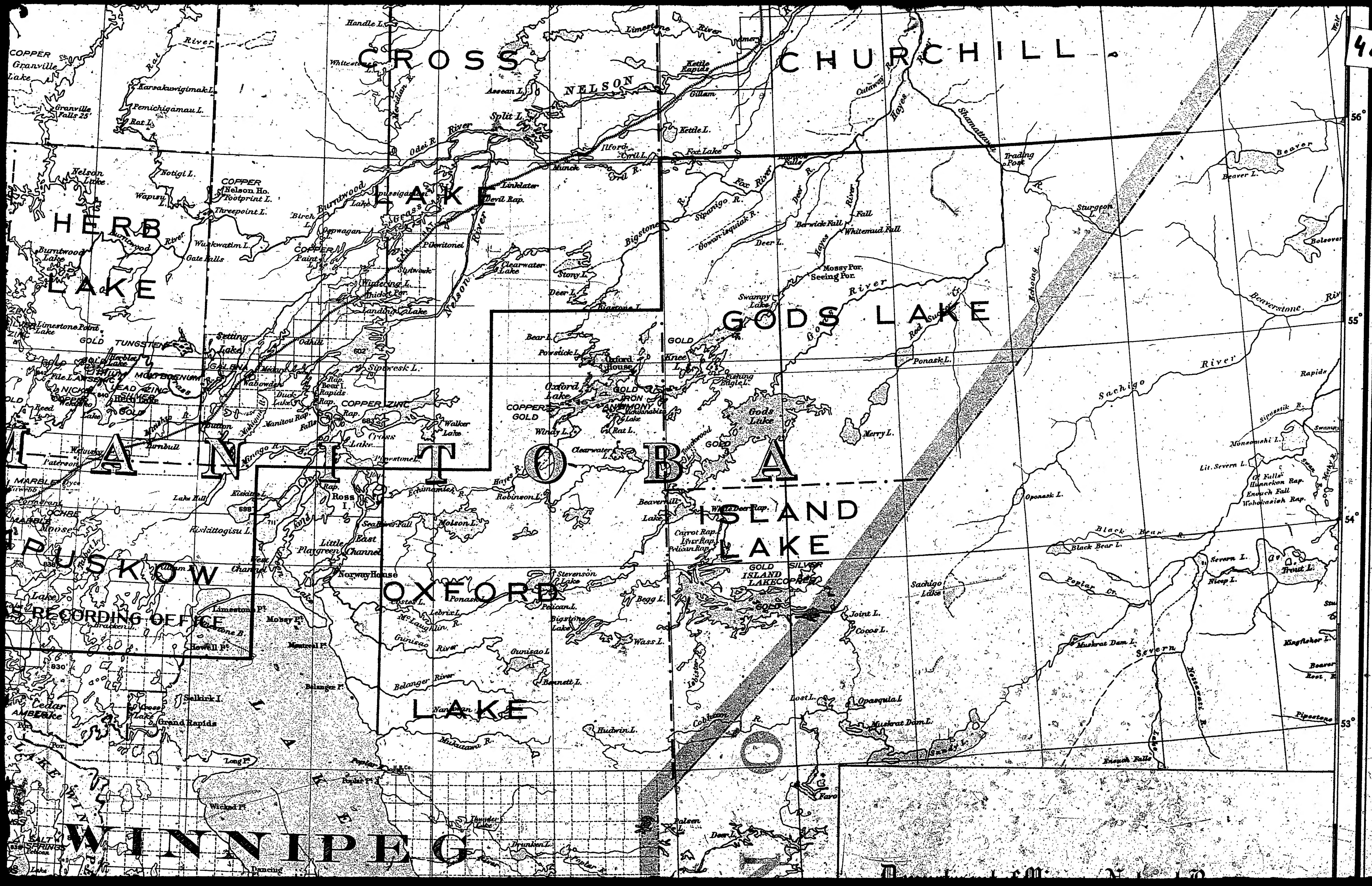

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CROSS
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GODS LAKE
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PUSKOW
RECORDING OFFICE
WINNIPEG
MANITOBA
Handle L.
Limestone River
Kettle Rapids
Gillam
Kettle L.
Fox Lake
Split L.
Odei R.
River
Assean L.
Ilford
Orill L.
Munck
Linklater
Devil Rap.
Burntwood
Nelson River
Nelson Ho.
Footprint L.
Threepoint L.
Notigi L.
Wapisu L.
Nelson Lake
Granville Lake
Granville Falls 25'
Karsakuwigamak L.
Pemichigamau L.
Rat L.
Burntwood Lake
Wuskwatim L.
Gate Falls
COPPER
GOLD
TUNGSTEN
Limestone Point Lake
Setting Lake
GALENA
Wabowden
Sipiwesk L.
Bear L.
Rapids
Duck Lake
COPPER ZINC
Walker Lake
Cross Lake
Manitou Rap.
Pipestone L.
Ross I.
Little Playgreen
East Channel
West Channel
Norway House
Kiskitto L.
Kiskittogisu L.
Lake Hill
Moose
MARBLE
Paterson
Clearwater Lake
Stony L.
Deer L.
Bigstone L.
Bigstone
Bear L.
Powstick L.
Oxford House
Oxford Lake
Knee L.
Fishing Eagle L.
Windy L.
Rat L.
IRON
ANTIMONY
Clearwater L.
Hayes R.
Robinson L.
Echimamish R.
Molson L.
Beaverhill Lake
Carrot Rap.
Pelican Rap.
Gods Lake
Merry L.
Swampy Lake
Mossy Por.
Seeing Por.
Gods River
Red Sucker
Ponask L.
Deer L.
Berwick Fall
Whitemud Fall
Fall
Fox River
Sipanigo R.
Hayes River
Shamattawa
Trading Post
Sturgeon L.
Beaver L.
Bolsover
Beaverstone
Sachigo
River
Rapids
Oponask L.
Black Bear L.
Severn L.
Trout L.
Nicep L.
Sachigo Lake
Poplar Cr.
Muskrat Dam L.
Severn
Kingfisher L.
Pipestone
Joint L.
Cocos L.
Stevenson Lake
Pelican L.
Begg L.
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Wass L.
Ponask
Lebrix L.
McLaughlin R.
Gunisao River
Gunisao L.
Bennett L.
Belanger River
Belanger Pt.
Mukutawa R.
Hudwin L.
Lost L.
Opasquia L.
Muskrat Dam L.
Sandy L.
Limestone Pt.
Mossy Pt.
Montreal Pt.
Howell Pt.
Selkirk I.
Cross Lake
Grand Rapids
Cedar Lake
Long Pt.
Poplar Pt.
Wicked Pt.
Thunder Lake
Drunken L.
Poplar
Dancing
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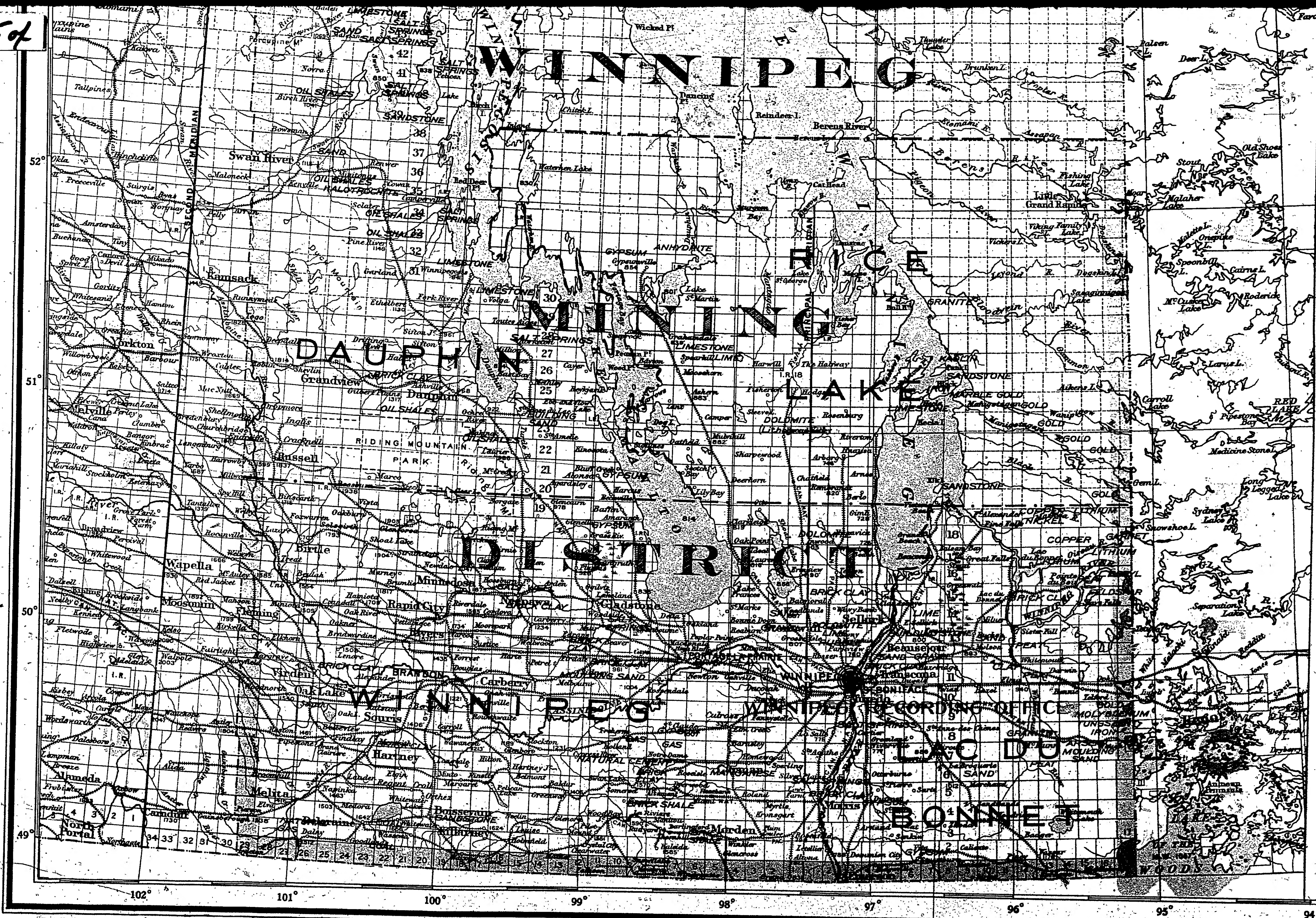

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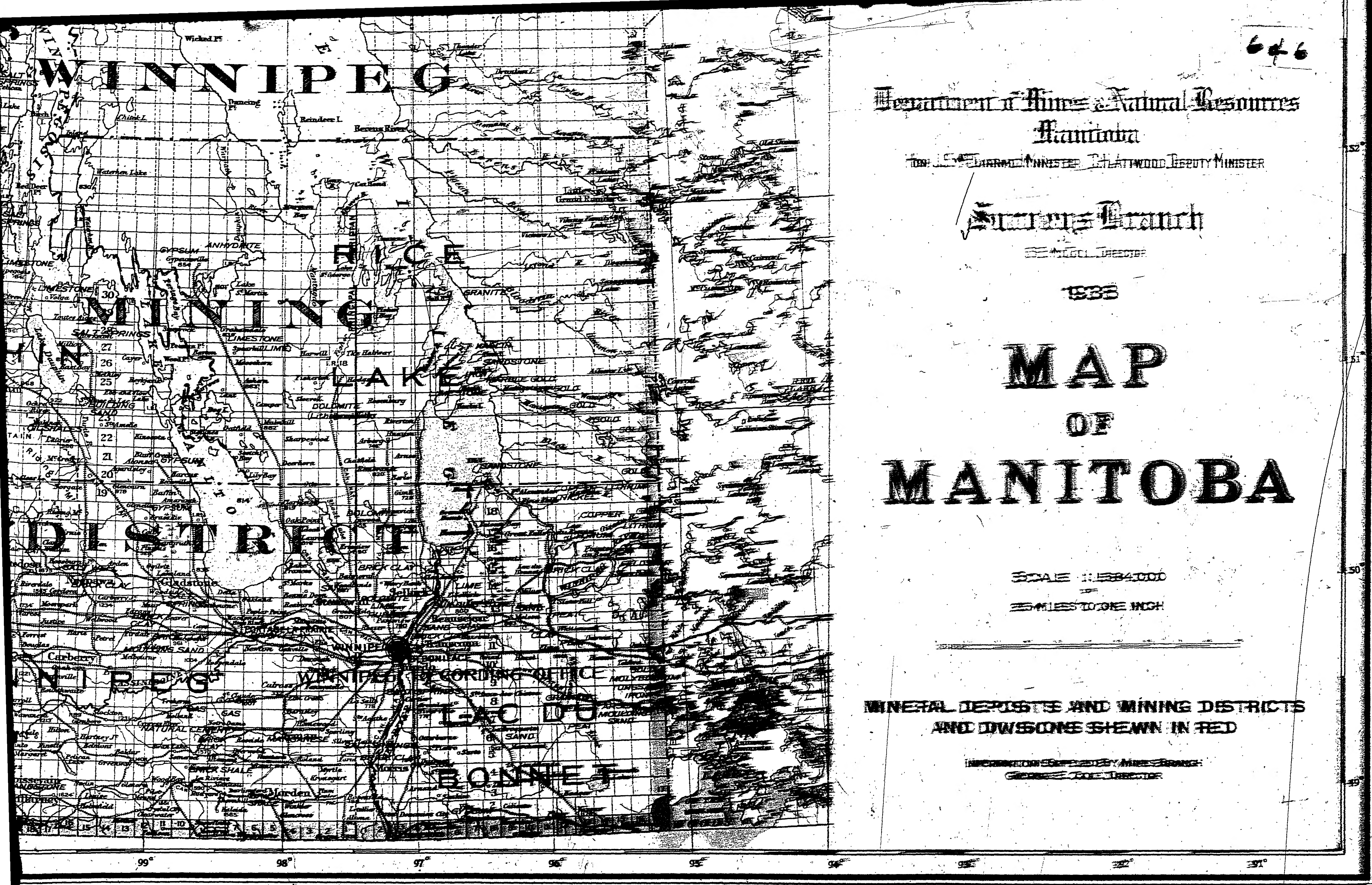
Department of Mines & Natural Resources
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MAP
OF
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25 MILES TO ONE INCH
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AND DIVISIONS SHEWN IN RED
WINNIPEG
RICE LAKE
MINING
DISTRICT
LAC DU BONNET
WINNIPEG RECORDING OFFICE
MANITOBA
Reindeer L.
Berens River
Waterhen Lake
GYPSUM
ANHYDRITE
LIMESTONE
SALT SPRINGS
GRANITE
SANDSTONE
DOLOMITE
GOLD
NICKEL
COPPER
BRICK CLAY
Gladstone
PORTAGE LA PRAIRIE
WINNIPEG
Carberry
Morden
Morris
NATURAL CEMENT
GAS
99°
98°
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